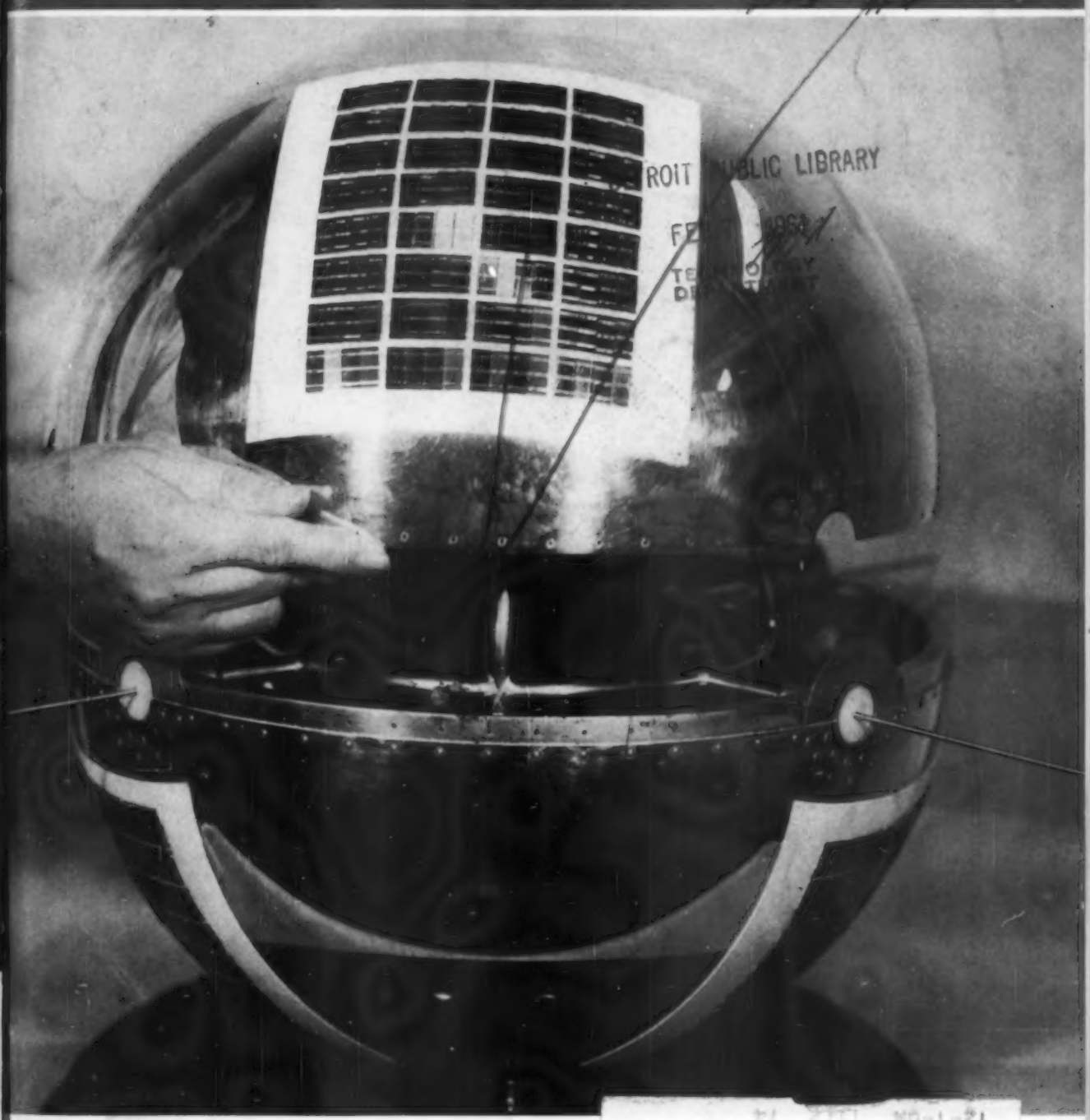
FEBRUARY 6, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY



Cubic's Proposed SECOR Satellite

Mercury, Minuteman, Samos Launchings
New Satellite Studied for Army SECOR . .
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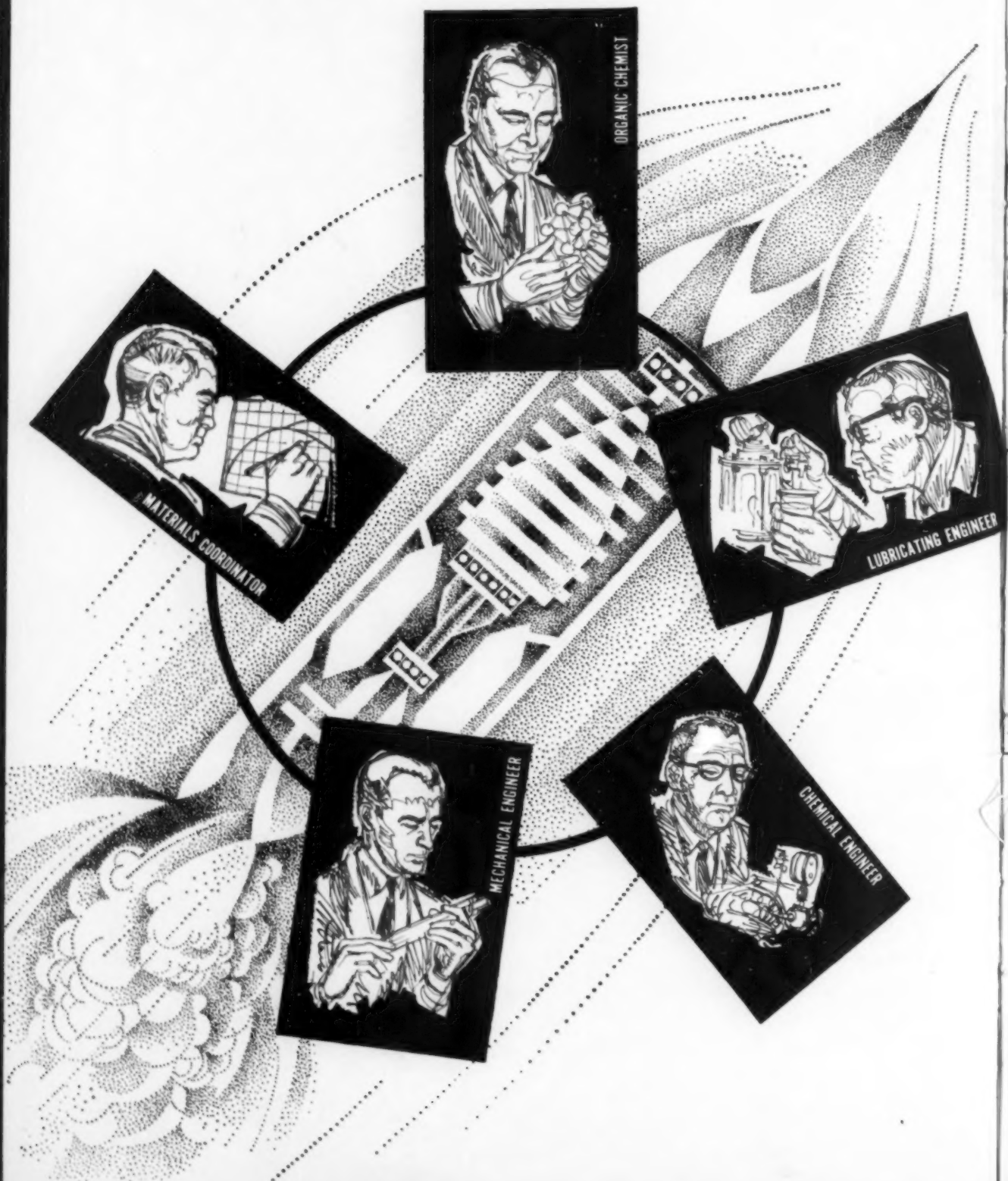
Monsanto

Space-Age Project "HIGH-TEMP-LUBE"

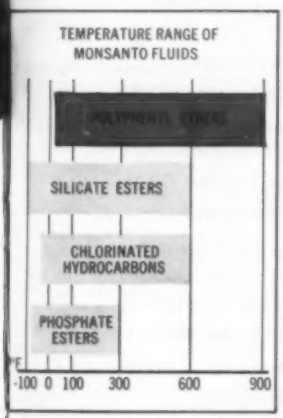
A CHEMICAL EXPEDITION . . .



.....seeking high-temperature lubricants for advanced jets and missiles...discovering new fluids that operate up to 900°F.

Monsanto has established a base of "know-how" in a new area of synthetic fluids: the polyphenyl ethers, fluids that exceed the high-temperature performance of all other known lubricants and hydraulic fluids. These newly synthesized liquids resist radiation damage, oxidation and chemical decomposition: as liquids they cover a temperature range of 20° F. to 900° F. Polyphenyl ethers are the result of creative chemistry applied to the problem of high-temperature lubricants; they were developed under contract and in cooperation with Wright Air Development Division, U. S. Air Force.

The heat stability of Monsanto's polyphenyl ethers is the result of enlisting chemical know-how on a problem of mechanical engineering. By design, lubricants for jet engines (and liquid fuel missiles) must lubricate and cool the bearings and accessory drive gears. Existing lubricants could not meet the requirements of advanced engine design. So the logical step was a Monsanto expedition into little-known fields of chemistry. A team of Monsanto scientists found and developed the polyphenyl ethers: to date, nineteen new compositions of matter.



In comparison with other synthetics, these lubricants are as thermally stable at 840° F., as are silicones and petroleum hydrocarbons at 740° F., and present commercial diesters at 540° F. Their useful temperature range exceeds all other fluids by 100° to 400° F.

Their chemical stability, physical properties, and lubricity recommend them for a host of other fluid applications: "hot" hydraulic systems; base stocks for high-temperature and/or radiation-resistant greases; and heat-transfer fluids.

Until development of the polyphenyl ethers, the calculated* useful life of the *best* synthetic lubricant was a scant 18 minutes at 900° F. Presently used synthetic lubricants would be effective for only 6 seconds to 3 minutes at this temperature. Polyphenyl ethers, however, would have useful lives of *20-80 hours* at 900° F.

*Based on the activation energy derived from isoteniscope data.

THERMAL STABILITY OF POLYPHENYL ETHERS VERSUS OTHER SYNTHETIC LUBRICANTS

Compound	Decomposition Point, °F.	Useful Life at 900° F.*
Bis (p-phenoxyphenyl) ether	824	25 hours
m-Bis (m-phenoxyphenoxy) benzene	862	80 hours
Bis-p (m-phenoxyphenoxy) phenyl ether	832	20 hours
Quaterphenyl	826	30 hours
Silicone	740	18 minutes
n-Octacosane	662	3 minutes
Tetra (2-ethylhexyl) silicate	638	14.4 seconds
Pentaerythritol tetrahexanoate	585	7.2 seconds
Bis (2-ethylhexyl) sebacate	525	7.2 seconds

**Time to decompose 10%*

Heat stability is one important facet of these new molecules. The polyphenyl ethers also match the lubricity and viscosity indexes of other good lubricants and possess better hydrolytic stability. They are two to five times more stable than most other synthetic fluids under nuclear radiation.

THE PROPERTIES OF THE MOLECULES

The unsubstituted polyphenyl ethers have the general molecular structure:

The "*n*" values range from 1 to 8, each with linkages in various combinations of the *ortho*, *meta* and *para* positions. The various isomeric polyphenyl ethers are all good lubricants: they show heat stability within a narrow range (the 7-ring ether decomposes only 20° F. higher than the 4-ring ether; a 5-ring appears to have the optimum thermal stability).

Varying the chain length does not materially affect lubricity or heat stability—as chain length increases so does pourpoint, and, conversely, volatility decreases. A 7-ring *meta* ether boils at 1150° F., has a pourpoint of 70° F. Chemically "tailoring" and blending can provide optimum lubricant properties.

While the properties of these fluids may solve many needs, the chemical expedition which found them set out to answer the specific problem of advanced turbojet engine and accessory lubrication. Turbine bearings, surrounded by hot gases, must be kept clean, cool and smooth-spinning. (*Please turn page.*)

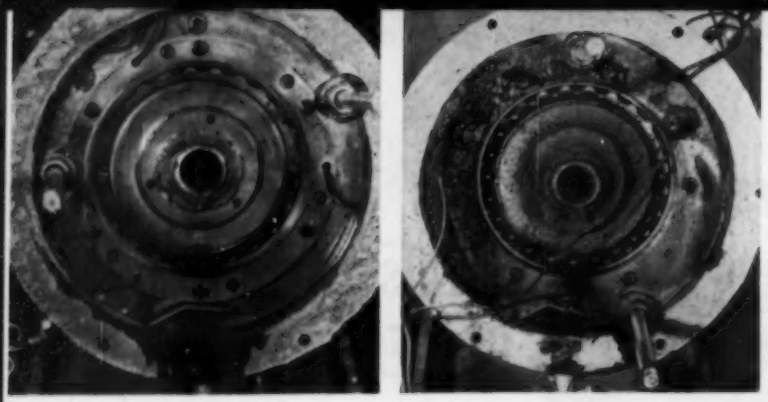


Photo Courtesy Pratt & Whitney Aircraft

Test rig parts for evaluating thermal and oxidative stability and lubrication properties of jet engine lubricants show how a polyphenyl ether (left) leaves the rig parts clean, free of deposits, and with no evidence of wear. Photo at right shows deposits and general condition of parts using one of the best synthetic lubricants prior to development of polyphenyl ethers. Both tests were run at a bearing temperature of 500° F. for 100 hours at a speed of 10,000 RPM.

Between Mach 3 and Mach 4, the skin temperature of craft in sustained flight at 40,000 feet can rise to 900° F., the temperature where steel glows red. In the lubricant reservoir, the polyphenyl ethers withstand this stress. Consequently, for speed brakes, hydraulic controls, fuel pumps and other internal moving parts, polyphenyl ethers can cope with the "heat barrier" to provide reliable performance.

Monsanto's polyphenyl ethers are a new link in the design chain leading to advanced engines and weapons systems with a minimum of "compromise" for lubricant and hydraulic fluid limitations. In present systems just "getting by" with marginal performance of earlier lubricants, the polyphenyl ethers can provide greater reliability.

SYNTHETIC FLUIDS FOR SPACE-AGE ENGINEERING

Monsanto has had 15 years' experience in the development of synthetic fluids and lubricants; currently markets over 20 fluids with applications that range from electronic coolant-dielectrics to fire-resistant hydraulic fluids for jets and radiation-resistant fluids for nuclear power plants.

If you require a fluid or lubricant for special use in an application of high stress, contact Monsanto. The material you need may be readily available or within "easy chemical reach." Write or call: MONSANTO CHEMICAL COMPANY, Department MR-1, C Building, St. Louis 66, Missouri.

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* High-Temperature Plastics
* Improved Nitrogen Oxidizers for Solid Propellants
* Fire-Resistant Structural Plastics
* Hydrocarbon Fuels for Jets and Missiles
* Fire-Resistant Hydraulic Fluids for Ground-Support and Missile-Launching Equipment
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* High-Temperature Lubricants and Additives
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* Inorganic Polymers
* High-Energy Solid Propellants

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THE MISSILE/SPACE WEEKLY

missiles and rockets

Volume 8, No. 6 February 6, 1961

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THE COVER

View of satellite assembly built by Cubic Corp., being studied as configuration for Army's SECOR precision mapping program. Note solar cells. Story starts on page 22.

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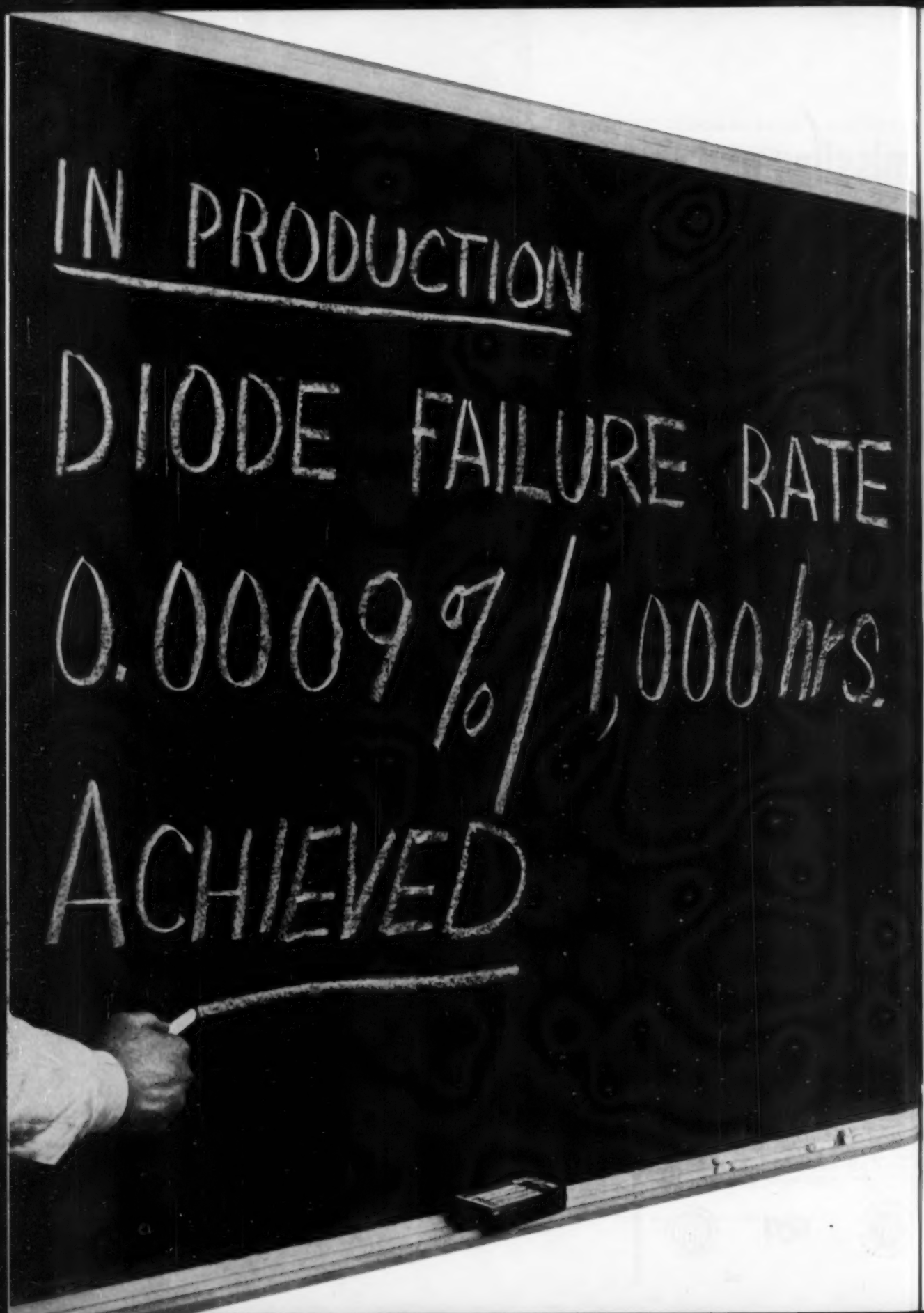
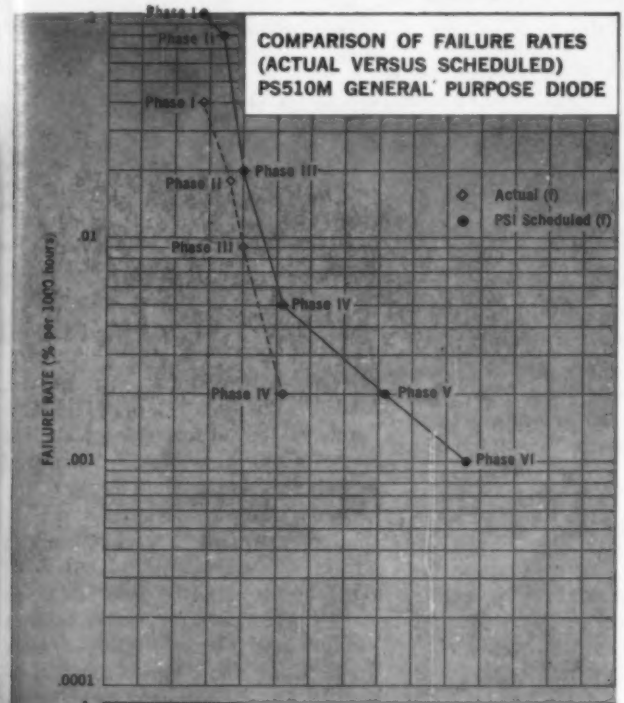
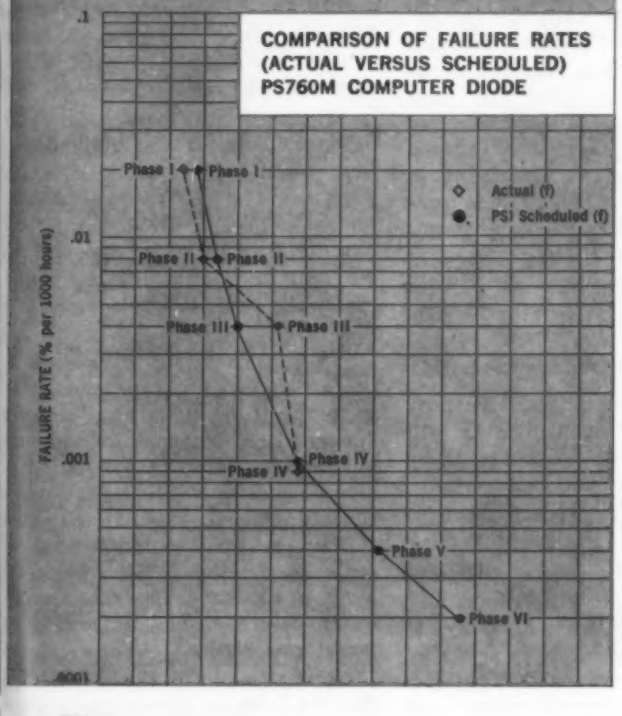

IN PRODUCTION
DIODE FAILURE RATE
0.0009%/1,000 hrs.
ACHIEVED

RELIABILITY...PROVED





PACIFIC SEMICONDUCTORS, INC., tests indicate failure rate of .0009% per 1,000 hours ACHIEVED for silicon computer diodes... .002% per 1,000 hours ACHIEVED for silicon general purpose diodes

PSI—qualified supplier of all silicon computer and general purpose diodes for the "Minuteman" ICBM guidance system—has undertaken a production and evaluation program designed to furnish "Minuteman" with ultra-high-reliability diodes. The program is being supported by the Air Force Ballistic Missile Division through the Autonetics Division of North American Aviation.

The ultimate reliability objective is a maximum failure rate of .0002% per 1,000 hours for silicon computer diodes, and .001% per 1,000 hours for silicon general purpose diodes—levels heretofore unattainable in the semiconductor industry. To achieve and prove this objective, more than 250,000 silicon diodes are being used to generate in excess of a billion diode hours of test information.

Results to date indicate that PSI is currently supplying "Minuteman" computer diodes with an indicated failure rate of .0009% per 1,000 hours, and general purpose diodes with an indicated failure rate of .002% per 1,000 hours.

Because of the huge quantity of high reliability diodes required in the "Minuteman" program, PSI has been able to make thousands of diode measurements and use these data to control processes. Since the same controls are applied to *all* PSI manufacturing processes – and *not just to a limited and specially isolated line*—PSI is able to supply high-reliability silicon diodes in large quantities and on a regular basis.

If you are associated with a program requiring ultra-high reliability semiconductor devices, you are invited to take advantage of the vast and growing fund of information and large volume production capacity available only at PSI. For full details, write to Richard A. Campbell, Executive Vice President, Pacific Semiconductors, Inc., 14520 Aviation Blvd., Lawndale, California (Los Angeles County).

PSI *Pacific Semiconductors, Inc.*

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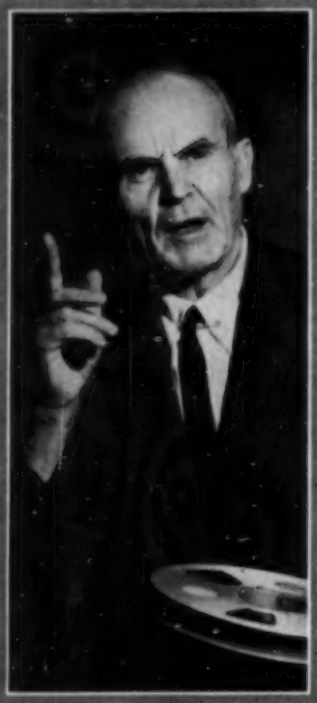

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The Missile/Space Week

New Space Probe

Within a few days, NASA expects to launch its *S-45* ionosphere beacon satellite. The 74-lb spacecraft—lofted by a *Juno II*—will transmit on six frequencies at varying power levels. This will enable ground stations to analyze the nature of the ionosphere as the *S-45* orbits at an apogee of 1600 miles and perigee of 240 miles in a 116-min. period.

The spacecraft is shaped like two truncated cones, back to back. It resembles *Explorers VII* and *VIII*. A 6-ft. loop antenna around its equator transmits low-frequency signals.

Nuclear Rocket Bids Due

The Atomic Energy Commission and NASA are inviting proposals by April 3 on research and development of a nuclear rocket engine.

Selection will be based on winners ability to carry out the entire engine development program which may run five years or more. Contract being awarded this year, however, will cover only the first phase, including assistance to the Los Alamos Scientific Laboratory in conducting the *KIWI B* test program and R&D on non-nuclear components. AEC-NASA nuclear propulsion office headed by Harold B. Finger is handling the contract.

'Cosmonaut'—Not Yet

Leading Soviet Scientist Yevgeny Federov says "much time is still needed" before the Russians will be able to orbit an astronaut.

The statement made in Moscow was an apparent attempt to debunk rumors that the Soviets had not only attempted at least one manned launch but had failed in returning the vehicles and sacrificed the passengers.

However, the Academy of Sciences Scientific Secretary said that the Soviets' success in orbiting biological specimens "has made it possible to be confident in the possibility of manned space flight." He cited the dangers of the return to earth as a factor which needs research before manned flight is possible.

Shots of the Week

The first tactical model Air Force *Bomarc-B* interceptor missile was successfully launched at Eglin AFB. At an altitude of nearly seven miles over the Gulf of Mexico, the missile made a scheduled near-miss intercept of a supersonic *Regulus II* drone travelling at almost 800 mph. The shot capped a week in which:

An Air Force *Minuteman*, loaded with 400 lbs. of test equipment, passed its first full-scale flight test of 4200 miles. NASA recovered its chimpanzee "Ham" after the animal enjoyed a successful, although extended (by 130 miles), trip of 420 miles in *MR-2*. At Point Arguello, an *Atlas Agena* lofted an Air Force *Samos* reconnaissance satellite into polar orbit. And back at the Cape, the 34-ft. Army *Pershing* (8 for 11) scored again in a 150-mile test of a new guidance system. It was fired from its transporter-launcher-erector.

The week also marked the third birthday (Jan. 31) of *Explorer I*, free world's first scientific earth satellite. The 18.13-lb. satellite, though it ceased transmitting 63 days after launch, is expected to last four to seven years longer and circles the earth 13 times a day.

More on Ball Lightning

Soviet research into the possibility of using lightning as a weapon has produced equipment for conducting a relatively small ball of lightning to undisclosed distances from a generating tube. A report, although sketchy in details, appears to bear out earlier belief (M/R, Aug. 24, 1959, p. 13) that such weapon applications were being developed by Soviet researchers.

Soviet scientists have reported that the lightning balls explode when they come in contact with catalyzers, releasing considerable energy.

Equipment for the experimental device is described as "a quartz tube with a special profile and with a heat-resistant non-conducting core which carries electric arcs.

M/R EDITOR COUGHLIN (standing) discusses layout with News Editor Reed Bundy and Managing Editor Bill Howard.

memo from the publisher

This week we introduce William J. Coughlin as M/R's new Editor.

Already well known in missile/space industry circles, Bill has included an enormous amount of traveling in his 15 years of very active reporting before landing in the editor's chair here in Washington.

While most of his journeys in the past few years have kept him close to the heart of the missile/space industry in Southern California, Washington D.C., and the nation's various missile test ranges, he can boast of having toured more than 30 countries on both sides of the Iron Curtain.

Bill has hunted moose in Alaska —flying a P-38 armed with camera instead of guns; switched to an aqualung to chase whales off the coast of Mexico. He has banged vodka glasses with Premier Khrushchev at a Moscow diplomatic reception and his was the first American family to make the trip to the Russian capital by car, as one London newspaper put it, "since the days of the Tsar." He is one of the few men to have explored the sunken hulk of the battleship Arizona at the bottom of Pearl Harbor.

After four years in the Air Force during World War II as a fighter pilot, Coughlin joined United Press, covered the Pacific for three years, later becoming UPI's San Francisco bureau manager. He held a Melville Jacoby journalism fellowship at Stanford University, of which he is a graduate. He has authored a book on Japan and his articles have appeared in such publications as *Readers' Digest* and *Harper's* magazine.

Bill was London and Moscow bureau chief for the McGraw-Hill Publishing Company before joining us here at American Aviation Publications. His military experience includes tours as a war correspondent in Korea and in Egypt during the 1956 Suez action. He has spent more than five years covering the aviation and missile/space industries on the West Coast, the last two of them as our West Coast bureau Chief. For several years, he was a regional director for the Aviation/Space Writers Association.

Bill is married; his wife Gerry and their three children soon will be joining him in Washington.

Clarke Newlon, who has been Executive Editor of MISSILES & ROCKETS since September, 1958, has resigned from the M/R staff to accept the position of Consultant for Military Affairs for American Aviation Publications, our parent organization. We will continue to make good use of his wide range of military and missile/space industry experience.

Edmund Mudfeld

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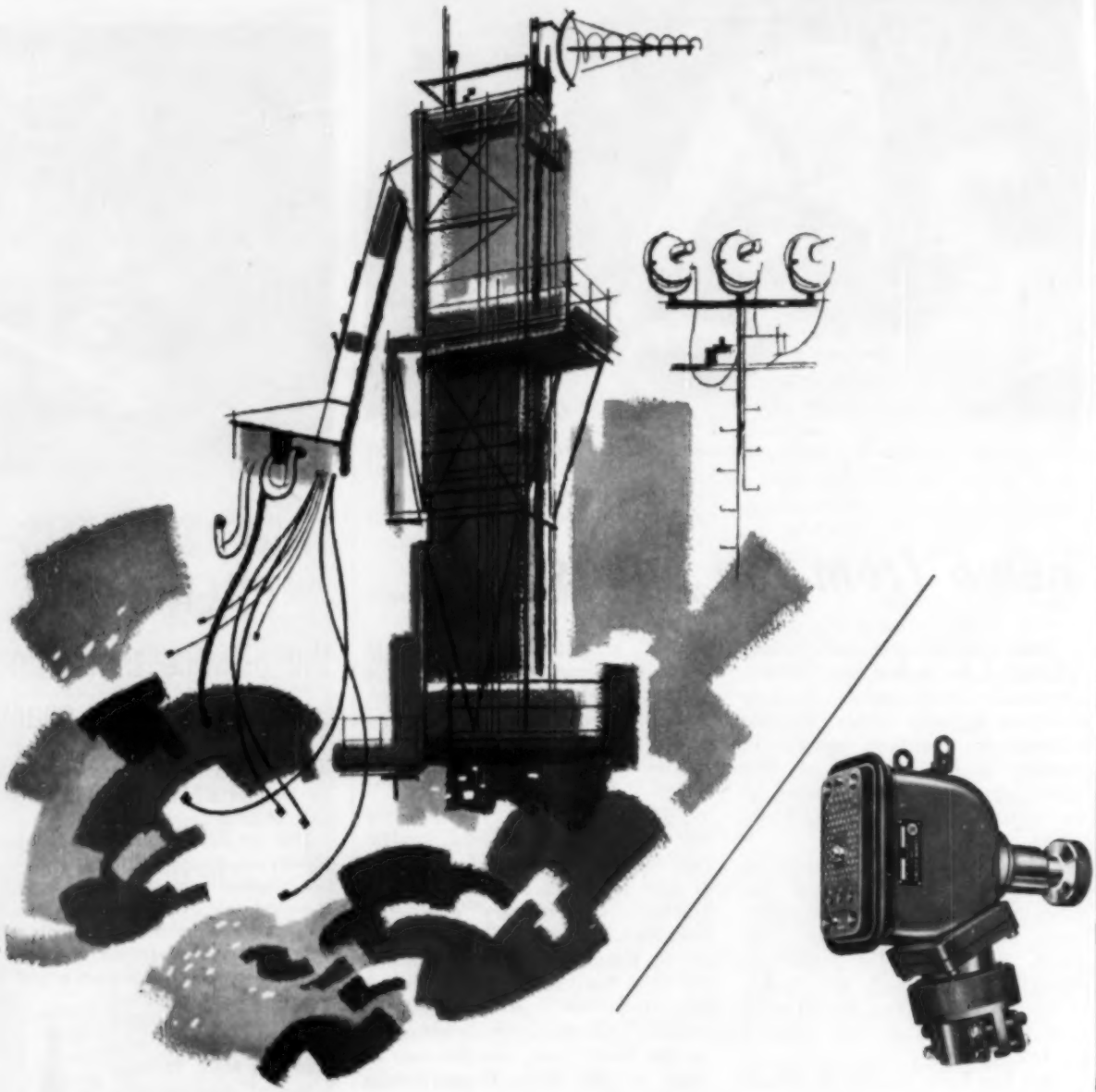

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The Countdown

WASHINGTON

Waiting for McNamara

The Kennedy-ordered review by Defense Secretary McNamara of all U.S. Defenses and U.S. defense strategy all but killed the possibility that Kennedy will seek a supplemental defense money bill for FY '61. The House Defense Appropriations Subcommittee is beginning hearings on the final Eisenhower defense budget. Other committees plan some tentative hearings on various aspects of the nation's defense and space programs. But, in general, everyone on the Hill is waiting for McNamara's report at the end of the month.

The Coming Gardner Report

One powerful input certain to be fed into the considerations of Secretary McNamara and his task forces will be the Gardner report on the Air Force's future needs in space. A high-powered committee headed by former Air Force R&D Secretary Trevor Gardner and including Presidential Science Adviser Jerome Wiesner is scheduled to complete the report and hand it to the Air Force in a matter of days. It is expected to advocate the need for both offensive and defensive military systems—manned and unmanned.

Polaris Cruisers: How Much?

The cost of putting eight Lockheed *Polarises* aboard the nuclear-powered cruiser Long Beach will be about $55 million. But the cost of deploying *Polaris* aboard other missile cruisers would be considerably less. Previous estimates for proposals that at least until now have been shelved say the pricetag for the first one would be about $49 million—the rest about $37 million.

Sky Bolt Bombers: When?

An Avro RAF Vulcan is being checked by Douglas for compatibility with the *Sky Bolt* ALBM. The program is moving ahead. But the essential point that still must be faced by the Kennedy Administration is that the *Sky Bolt* will be ready later rather than sooner, unless present funding propopsals are reversed. The 1964 target date looks less and less likely.

Victims for Zeus Arrive

The first two *Atlases* that will be used as targets in the *Nike-Zeus* Pacific tests are reported to have arrived at Convair's San Diego plant for modification. Their re-entry vehicles will be made capable of simulating decoys. Their guidance systems also are expected to be modified or possibly replaced. The first *Zeus* vs. *Atlas* tests may come late this year.

Red General Prowls the West

Air Force Gen. Mikhail N. Kostiuk, air attache to the Soviet Embassy in Washington, showed up this last week at the ARS meeting in Salt Lake City shadowed by CIA agents. Theme of the meeting: solid propulsion. Asked if Russia were particularly interested in solids, Kostiuk replied affably: "If I knew I would tell you, but I don't know."

INDUSTRY

Threat from Abroad

Many missile makers are becoming increasingly concerned over foreign competition. "We've got to look out," says one project manager, "that we don't price ourselves out of the market." While the military services are pressing hard on cutting costs, this manufacturer believes loss of business to foreign concerns—particularly in the missile component area—will be the greatest spur to lower prices.

Mahogany Row

Major reorganization of General Dynamics electronics activities may pressage a company drive to become a system bidder on upcoming space contracts. G-D is setting up a new division, which will absorb its Stromberg-Carlson division and all other electronics manufacturing throughout the company. James D. McLean, president and general manager of Stromberg-Carlson, moves over as chief of the new General Dynamics/-Electronics . . . North American Aviation is letting it be known that it is looking for "the right" growth company to buy so it can expand in commercial fields . . . McDonnell Aircraft has set up a new Electronics Equipment Division.

Where Did He Go?

Dr. G. B. Kistiakowsky, Presidential Science Adviser to Eisenhower and one of the most powerful members of the Eisenhower Administration, is now chairman of Itek Corp.'s new science board and an Itek director. The science board will assist Itek directors in guiding and evaluating technical programs.

Double Jeopardy Here to Stay

All signs are pointing to full use by Congress of its new rule that procurement of missiles, aircraft and ships must now be authorized as well as funded despite objections from the Pentagon and the outgoing Eisenhower Administration. That means programs will have to go before two committees in each house instead of one. However, at least at first, it looks as if procurement will be authorized in dollars rather than items.

INTERNATIONAL

France's Space Program

French scientists are planning to launch about a dozen high altitude probes this year—five of them *Veroniques*. The new Program Law (see page 40) sets aside $26 million for space research over the next five years. Once fully under way, about 50 probes a year will be launched. But there is no money as yet for satellites which would enable the French to join in Britain's proposed "space club."

New Sounding Rockets

Two new sounding rockets expected to be used in the French space program are Sud Aviation's *Bélier* and *Centaure*. Experiments will study explosions at high altitude and ionization layers formed around re-entry vehicles.

Overseas Pipeline

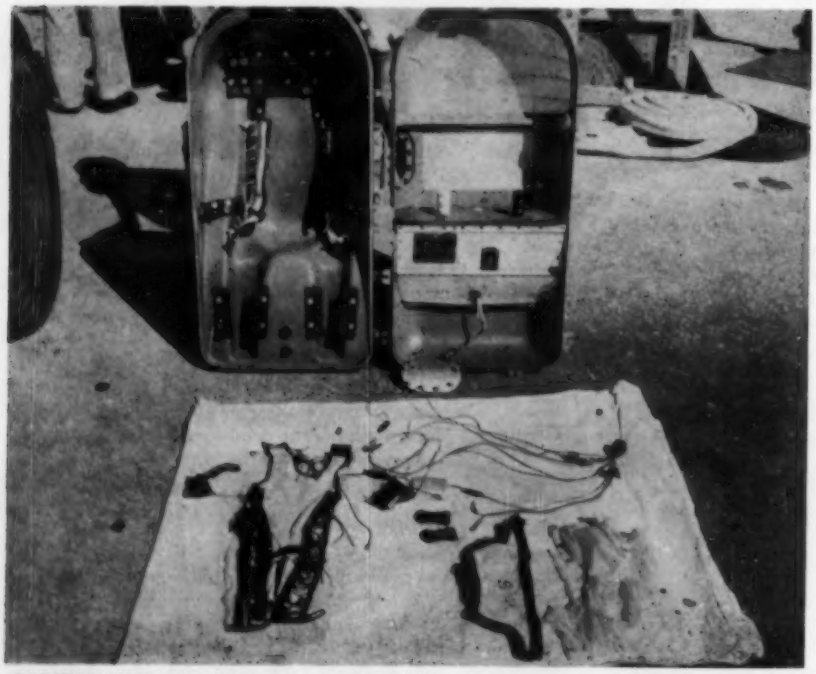
Aerojet-General is licensing SETEL of France to produce *Hawk* antiaircraft missile motors . . . Britain's Royal Radar Establishiment is developing a camera to photograph ninth and tenth magnitude satellites with an accuracy within 2 sec. of arc . . . Using a copper-plating technique, the Russians are now drawing aluminum wire to 5-7 microns in diameter.

'Ham' shows the way . . .

Manned Shot Could Come Soon

MR-2 success—despite faulty rocket performance—boosts prospects that U.S. may yet win race to launch and recover a human

SMILING CHIMP lies in life couch before being put aboard capsule.



COMPONENTS OF chimpanzee couch and life support system laid out before flight.

by Hal Gettings

CAPE CANAVERAL—With the last major obstacle out of the way, an astronaut now seems certain to attempt America's first manned ballistic space flight soon—perhaps within 60 days.

One comparatively minor flight test—the final qualification of the *Mercury* capsule escape system with a *Little Joe* rocket—remains.

The success of last week's *Mercury Redstone 2*—despite faulty operation of the *Redstone* rocket—gave conclusive proof that a manlike animal can survive and perform at his normal capacity during five minutes of weightlessness in a space environment. The results spurred hope that America will win the race with Russia to put a man in space and return him safely.

Ham, the 37-lb., 3¾-year-old male chimpanzee who rode in the *MR-2* capsule, is one of the largest animals ever brought back from space alive. The dogs returned from last summer's Soviet orbital flight weighed only 10 to 15 lbs.

• **Slow progress**—The *Redstone* phase of the *Mercury* program, which slipped six months to a year behind early optimistic schedules last year, now is moving along steadily. There is still no word when *Atlas* flights will be resumed, although a decision on the scheduling of the next *Atlas* flight is expected soon. Manned orbital flight is still officially targeted for the end of 1961, but early 1962 now seems to be the earliest possible date.

The *Little Joe* test, to be launched from Wallops Island, will subject the escape system to the most severe conditions that might be anticipated in an abort during boost by an *Atlas* for an orbital flight. Thus it is not a basic part of the *Mercury Redstone* qualification program.

Nevertheless, National Aeronautics and Space Administration officials will await the results of the *Little Joe* flight before completing arrangements for the manned *Mercury Redstone 3*. In point of fact, no formal decision has been made to put an astronaut aboard *MR-3*. Careful studies must be made of the telemetry, capsule and chim-

panzee from the Jan. 31 *MR-2* flight. But in view of the obvious success of its major endeavor—to show that the capsule is capable of supporting a man-like creature—there is little doubt of the decision.

• **Gain from malfunction**—The faulty operation of the specially modified *Redstone* actually provided a bonus in proving out the capsule escape system in the *MR-2* flight. It worked perfectly.

The *Redstone* engine thrust regulator failed to hold thrust within desired limits. As a result, propellant was consumed too fast and LOX ran out about five seconds sooner than programed. The early burnout—a second or two sooner than the programed tolerance of the abort sensing system—created a "red line" situation that automatically fired the escape rockets.

To reduce capsule weight to a minimum, the posigrade and retrorocket package is left behind when the escape system is fired. Thus, when the escape rockets were fired at 200,000 ft. after about 140 seconds of powered flight, they cut out the possibility of retro-firing to slow the capsule for re-entry. And, since there was virtually no atmosphere at that altitude, the parachutes did not deploy until re-entry.

The excessive *Redstone* thrust added about 700 fps to the programed velocity of 6500 fps (4400 mph). The escape rockets added about 500 fps. The absence of retrorockets eliminated the possibility of slowing the capsule by about 500 fps at apogee.

As a result, the capsule was traveling at more than 500 mph after apogee—about 1700 fps faster than programed. As a result, it rose to an altitude of 155 statute miles instead of 115, and traveled 420 miles down the Atlantic Missile Range, 130 miles beyond the area where seven vessels of the Navy's Destroyer Flotilla 4 were waiting.

• **Well and happy**—Search planes spotted it in the water less than an hour after the 11:15 A.M. (EST) launch. The fleet steamed to the area, about 175 miles east of Grand Bahama, and the USS Ellison sighted the capsule floating on its side at 2:30 P.M. Two sailors in a rubber raft put a line on and righted it in the water. Then a helipcoter picked the capsule up at 2:52 and placed it on the deck of the USS Donner at 3:41 P.M., just 3 hours and 46 minutes after launch.

Maj. R. E. Benson, Air Force veterinarian, examined the animal, pronounced him in good condition and approved a supper consisting of an apple, a half orange, a small wedge of lettuce and not more than 300 cc of water for the first six hours. The animal appeared lively and ate the meal.

Ham spent the night aboard the Donner and was flown to Grand Bahama by helicopter the following morning. Later that day, he was returned to the Cape for a further flight to his base at Holloman AFB, N.M.

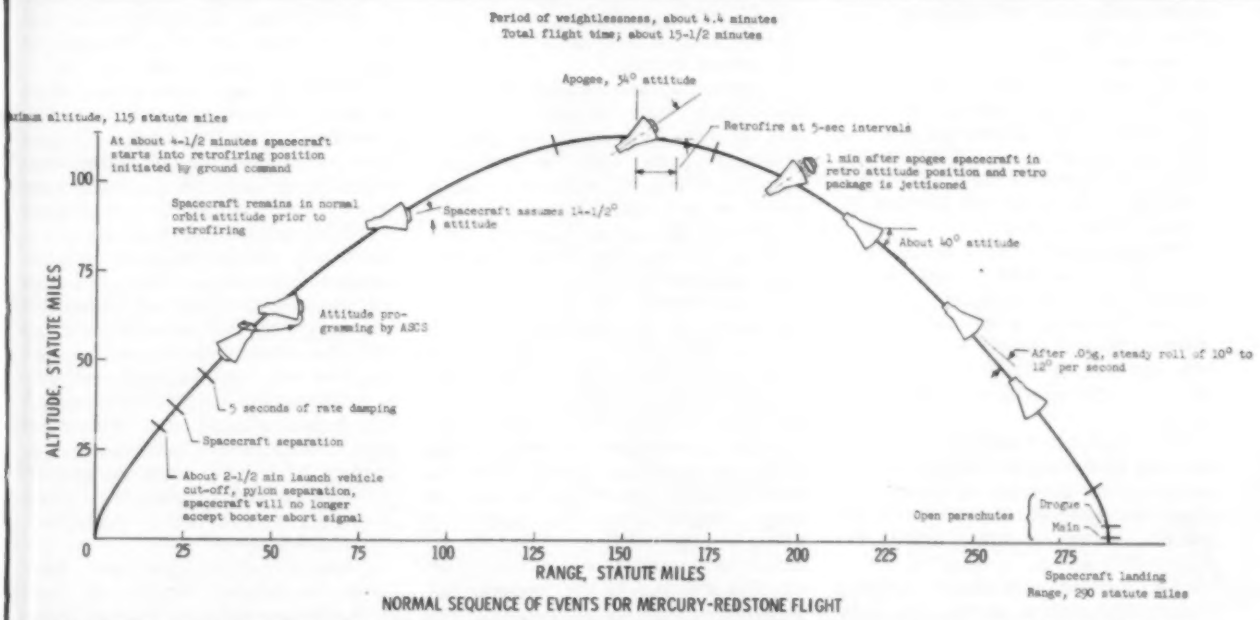
George M. Low, chief of manned space flight at NASA headquarters, reported that the animal apparently performed perfectly in its little game with flashing lights. Observers at the command console saw no indication that he failed to react to stimuli during boost, free flight and re-entry, although he had to withstand a greater re-entry stress than the expected 7 g.

• **New escape test**—The *Little Joe* flight—which may come as soon as next week—is a repeat of the unsuccessful *Little Joe 5* last Nov. 8. It will test the booster separation and escape systems that almost duplicate the most severe conditions it might encounter as it leaves the atmosphere.

In the Nov. 8 flight, the escape rocket received a premature signal and fired before the capsule had been separated from the *Little Joe* booster by the firing of explosive bolts to release the clamp ring. As a result, the escape rocket merely added to the velocity of the whole vehicle. Later, the bolts released the clamp ring at the proper time and gave another signal to fire the escape rocket, but it had already burned out.

The trouble was quickly located and the electronic circuits were rewound in time for the first attempt at firing *MR-1* on Nov. 21. The electronic system now has worked properly on two flights, *MR-1* and *MR-2*. The only question remaining to be settled by *Little Joe 6* is whether the system will work under maximum aerodunamic Load.

Low said there is a possibility that the second *Mercury Atlas* will also be launched before the manned *Redstone*. But he said the manned flight will not wait for the *Atlas*, since the *Redstone* and *Atlas* programs are separate from one another. ⌗


Period of weightlessness, about 4.4 minutes
Total flight time; about 15-1/2 minutes
Apogee, 34° attitude
Retrofire at 5-sec intervals
1 min after apogee spacecraft in retro attitude position and retro package is jettisoned
About 40° attitude
After .01g, steady roll of 10° to 12° per second
At about 4-1/2 minutes spacecraft starts into retrofiring position initiated by ground command
Spacecraft remains in normal orbit attitude prior to retrofiring
Spacecraft assumes 14-1/2° attitude
Attitude programming by ASCS
5 seconds of rate damping
Spacecraft separation
About 2-1/2 min launch vehicle cut-off, pylon separation, spacecraft will no longer accept booster abort signal
Open parachutes
Drogue
Main
ALTITUDE, STATUTE MILES
RANGE, STATUTE MILES
Spacecraft landing
Range, 290 statute miles

NORMAL SEQUENCE OF EVENTS FOR MERCURY-REDSTONE FLIGHT

PROGRAMED FLIGHT PLAN called for capsule to travel 290 miles. It went 420 miles, was recovered in 3 hours, 46 minutes.

Minuteman Passes First Flight Test

Success in full-scale shot scores a missile 'first'— near-operational 1st stage is being modified

NEXT BIG TEST for Minuteman will be shot later this year from launch car made by ACF Industries and American Machine & Foundry. Car cost about $1 million.

STILL FLUSHED with the success of the first complete R&D launching of a *Minuteman*, the Air Force is pressing ahead with plans to make improvements in the big ICBM's first-stage motor.

However, it was made clear that the improvements would not be made until well into the planned two-year test program—probably early next year.

The present test schedule calls for at least several more launchings from pads at Cape Canaveral, and then a new series from an operational-type silo beginning this summer.

The exact nature of the planned changes was not disclosed. But the Air Force stressed that the *Minuteman* launched from the Cape Feb. 1 was a "virtually operational" bird.

The launching marked the first time in a major missile R&D program in which a complete bird was flown.

All three stages of the *Minuteman* ignited successfully in the test flight, and it impacted in the programed target area 4200 miles down-range.

The test bird carried an 18-in.-long instrumentation section between the guidance section and third-stage engine. This package contained the radio tracking system, optical beacon, and command-destruct, telemetering, and power systems.

Instrumentation antennas, designed to protrude from the section rather than be flush-mounted—in order to save weight and space—are covered with an ablation material for heat protection. The ground system used in the test firing is essentially the same as the operational equipment.

• **Some firsts**—The solid-fueled 6300-mile *Minuteman* boasts several important firsts in its design.

The first stage is the largest solid engine with the highest I_{sp} propellant ever flown. It is the first solid engine to use movable nozzles for thrust-vector control.

The thin-walled steel case serves as the body of the engine—eliminating the need for an airframe as such. This allows assembly of the missile at the test site—as was done here for this test shot.

Use of the operational guidance and control system in the test flight also marks a significant first. The G&C system is integrated with a solid-stage digital computer which takes information from velocity meters and uses it to generate steering signals and staging and thrust-termination signals.

After first-stage burnout, the G&C system senses the rust decay and ignites the second stage at the proper point (about T plus one minute). The same procedure ignites the third stage.

• **'Bold approach'**—Primary objective of this first test firing was to test first-stage ignition, lift-off, launch technique, prelaunch checkout, and instrumentation. Secondary objectives—considered a bonus in this shot—were second- and third-stage performance and overall operation.

Design and test philosophy of the *Minuteman* centers around what Col. Sam Phillips, director of the Weapon System Program, calls the "bold approach." Principally, this means going all-out on new and different concepts: the remote silo and train launch, movable nozzles, integrated G&C, and full-scale flight-test vehicles.

"Concurrency and compression" is the theme of the program. Research and development is on the tightest schedule ever attempted for an ICBM.

An example of the manner in which the program is being pushed, BMD cites the silo development tests begun a little over a year ago. Within about six months, eight consecutive test missiles were launched and the program—which originally called for 18 test vehicles—was called completed. This was the first step in the four-part test program.

The flight-test phase—beginning at AMR with the Feb. 1 launch—will continue through a series of pad and silo launches.

The third phase will be the complete component compatibility checkout, involving all elements of the total weapon system. Also, during this phase, handling procedures at the Boeing-Seattle launch complex will be determined.

Fourth and final step in the program will be the demonstration of the operational system and training of AF crews at Vandenberg AFB. Firing of a test vehicle from a railroad launcher will probably occur within a year. The mobile system is scheduled for operational status in 1963.

• **Progress on bases**—Two fixed *Minuteman* bases are already in the planning stage. The first of these hardened sites will be near Malmstrom AFB, Great Falls, Mont. Deployment of the second wing—three squadrons—will be at Ellsworth AFB, S.D.

Award of the first construction contract is scheduled within the next few months. The original Malmstrom bids were rejected due to problems with the specified construction schedule. The schedule has been readjusted to accommodate winter construction in the rugged climate, and re-bids are due shortly. BMD officials say no changes have been made in base design and revised construction schedules will not affect present deployment target dates.

Feasibility studies are now being conducted in the vicinity of Pease AFB, Portsmouth, N. H., to determine whether that site is suitable for a projected third hardened base.

Soviet reaction awaited . . .

Samos II Big Triumph for U.S.

Camera-carrying satellite replaces U-2 as major reconnaissance weapon; Air Force declines to discuss details of payload

POINT ARGUELLO, CALIF.—An Air Force *Samos II* satellite capable of photographing any point on the earth's surface with high-resolution cameras is orbiting over the Soviet Union and the rest of the world this week.

Once again, a missile has replaced an aircraft: *Samos II* is designed to do a job previously carried out by the U-2. When fully developed, the sensitive cameras aboard *Samos* (Satellite and Missile Observation System) will be able to photograph Soviet missile bases and troop movements even by starlight.

Industry sources say the Eastman Kodak and Ansco camera system for *Samos* can take detailed photos of ground installations which equal what the human eye would see at 100 ft. These are developed aboard the satellite and relayed earthward by television on command.

The research and development model was launched Jan. 31 at 12:33 p.m. from this Navy space base near Vandenberg AFB. A little more than two hours after it rose from its ocean-side pad into an overcast sky, word came that the *Agena* second stage had fired successfully and placed the vehicle into a 300-mile polar orbit.

Success came on the second attempt. Last Oct. 11, *Samos I* failed to achieve orbit when a faulty umbilical disconnect damaged the second stage.

• **Secrecy on photos**—Air Force officers refused to list the photographic equipment in the 3 and ½-x-4-ft. payload section of *Samos II*. But it was made clear that the satellite would take photos and that means were available to "assess" the quality of these.

Ground stations in California, Hawaii and Alaska were in communication with the satellite.

The Air Force would not say whether this means actual transmission of the photographs to earth by *Samos II*, although this is of course a prime objective of the program.

There was no plan to recover a film capsule from *Samos II*, although this is expected later in the development stage with equipment being tested in the *Discoverer* program.

Although the Air Force would not confirm it, payload of *Samos II* was similar to that of *Samos I*, which carried in addition to test photographic equipment, instrumentation to measure cosmic rays, micrometeorites and the earth's electrical field.

Launch of an operation *Samos* is not expected before next year.

• **Limited details**—First stage of the vehicle is a modified Convair *Atlas* weighing 262,000 lbs. at lanuch. It is 77 ft. in height. Second stage is a 22-ft. Lockheed *Agena A*, with an 11,000-lb. launch weight.

The entire *Agena* vehicle is in a 95-min. orbit and was programed to tilt so that cameras in the nose section point constantly toward earth. An in-flight control system maintains this attitude.

Although *Samos II* is expected to remain in orbit at least a year, transmitters aboard the satellite are expected to operate for only 20 days. Another limiting factor in the experimental model will appear with exhaustion of the gas supply to the jets which maintain the nose-down attitude of the cigar-shaped vehicle.

Reluctance to give further details of the *Samos* payload is coupled with the question of Soviet reaction to the spy satellite. ⠿

Europeans Debate 'Space Club'

by Anthony Vandyk

STRASBOURG, FRANCE—Britain proposed last week that four nations share the major cost of a cooperative launch program which would put an all-European communications satellite into orbit by 1966.

Cost was estimated at approximately $200 million, spread over five years.

British delegates to the European Space Conference here suggested that the financing should be 25% British, 22% French, 18% German and 11% Italian. Other participants would contribute less than 5% each, with the major powers making up any shortages.

Initial reaction to the proposal was favorable. It had strong backing from France.

The $200-million program calls for nine major firings, the last three of which could put satellites into orbit in the fifth year. Launchings would begin 12 months after the program is started. Ten *Blue Streak* vehicles for the first stage already are undergoing testing at Woomera Missile Range, Australia.

Second stage of the launch vehicle would be French and the third stage "European."

Reports were confirmed that extensive assistance in *Blue Streak* development was provided de Havilland by Convair. The *Blue Streak* has the same diameter as the *Atlas* and the motors are modified Rocketdyne engines built by Rolls-Royce. The French are expected to design an entirely new second stage since the *Veronique* is not considered powerful enough.

The proposed launcher would put a 330-lb. satellite into an 8500-mile orbit, using high-energy fuel in the third stage.

The British are backing a communications satellite as offering the best possibility of a financial return on the program. Delegates from both France and Britain believe the communications satellite angle might move some governments to release funds they would be reluctant to authorize on a pure research program.

Other delegations present included Austria, Belgium, Denmark, Germany, Italy, Netherlands, Norway, Spain, Sweden and Switzerland. Canada, Ireland, Greece and Turkey sent observers.

Cost is expected to be a knotty problem the European nations will have to untangle before the space program gets underway. Initially the program will probably only call for the orbiting of small satellites in the 200-300-lb. category. After a three-year scientific program, satellites in the 1000-5000-lb. weight category might be launched into terrestrial orbit. ⠿

In speech to Congress . . .

Kennedy Calls for Defense Beef-up

by James Baar

THE NAVY IS PLANNING to launch one *Polaris* submarine a month in line with an explicit—and implicit—go-ahead ordered by President Kennedy in his State of the Union message.

At the same time, the Army is increasingly optimistic that it will receive sizeable budget increases to build up its limited war punch.

However, all other service plans for boosting the nation's military strength are being held in abeyance while Defense Secretary McNamara and four special task forces conduct an overall review of U.S. defenses.

These plans include such big money proposals as a speed up of the *Minuteman* ICBM program, production of the *Nike-Zeus* antimissile missile and a full-scale military space program aimed at developing both defensive and offensive space systems.

Kennedy touched only lightly on space matters. He said the United States is "ahead in the science and technology of space while the Soviet Union is ahead in the capacity to lift large vehicles into orbit." And he added "these endeavors" should be removed from the Cold War.

"I now invite all nations including the Soviet Union to join with us in developing a weather prediction program, in a new satellite program and in preparation for probing the distant planets of Mars and Venus, probes which may someday unlock the deepest secrets of the universe."

Kennedy did not discuss such space projects as the *Samos* reconnaissance satellite or manned military space systems.

• **Reports coming**—The four task forces are expecetd to make preliminary reports about Feb. 20. These reports, in Kennedy's words, will reappraise the entire U.S. defense strategy in light of:

"—Our ability to fulfill our commitments

"—The effectiveness, vulnerability and dispersal of our strategic bases, forces and warning systems

"—The efficiency and economy of our operation and organization

"—The elimination of obsolete bases and installations

"—The adequacy, modernization and mobility of our present conventional and nuclear forces and weapons systems in the light of present and future dangers."

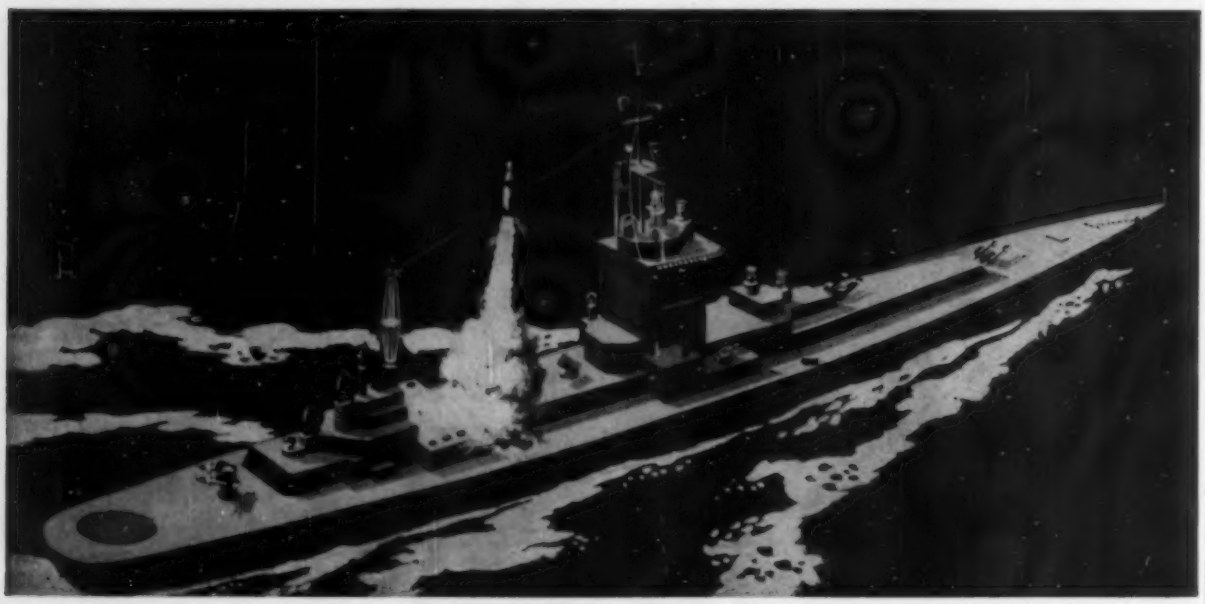
The reappraisal began immediately after Kennedy took office Jan. 20. The four task forces are headed by Pentagon Comptroller Charles P. Hitch (strategic weapons); Paul H. Nitze, Assistant Defense Secretary for International Security Affairs (U.S. commitments and limited war requirements); Defense R&E Director Herbert York (all weapons R&D); and Thomas D. Morris, Assistant Defense Secretary for Logistics (U.S. bases).

• **Bigger effort**—Kennedy said the studies are necessary because "lack of a consistent coherent military strategy, the absence of basic assumptions about our national requirements and the faulty estimates and duplication arising from interservice rivalries have all made it difficult to assess accurately how adequate—or inadequate—our defenses really are."

Kennedy nevertheless made clear that the nation must strengthen its "military tools." And he promised Congress that once he received the task force reports from McNamara that he would "recommend whatever legislative, budgetary or executive action is needed."

"We are moving into a period of

(Continued on page 39)



Long Beach with Polaris

SEABORNE POLARISES will be deployed aboard the nuclear powered Cruiser Long Beach—first of a possible fleet of Polaris cruisers. The Long Beach will carry eight Polarises and other missiles. She will be operational in late 1963.

Webb Surprised Choice to Head NASA

Widely experienced in administration

NEW NASA CHIEF James E. Webb, a long-time business associate of Senate Space Committee Chairman Robert S. Kerr, has promised to divest himself of any possible conflict-of-interest stockholdings.

Among other interests, Webb holds a directorship in the McDonnell Aircraft Corp.—prime for NASA's *Mercury* man-in-space program.

Selection last week of the 54-year-old industrialist-attorney came as something of a surprise. He had not been mentioned as even a "dark horse" candidate for the post vacated by educator T. Keith Glennan. And Webb himself conceded that the appointment came about rather suddenly.

Hugh L. Dryden, deputy administrator under Glennan, will continue in the same capacity under the new administrator.

The delay in filling this major post in the Kennedy Administration apparently was caused partly by a behind-the-scenes disagreement between Kerr and Vice President Johnson and some of Kennedy's other advisers. Kerr and Johnson reportedly wanted a man with an industry background, while the opposition favored a man from scientific ranks.

There was also speculation that possible candidates had sidestepped the job because the future of NASA was still rather hazy. Although Kennedy has indicated he wants a space program to catch up with Russia, he has not made clear whether it should be undertaken by NASA or the military.

It is understood that Kennedy's scientific adviser, Dr. Jerome Wiesner, agreed to Webb as a compromise. Webb said Wiesner telephoned him in Oklahoma City on Jan. 27 to ask whether he was interested. Webb agreed, and the White House announced the appointment three days later.

• **Extensive background**—The new administrator told newsmen that he assumed he was chosen primarily for his administrative experience. He served three years as Director of the Budget Bureau and three years as Under Secretary of State during the Truman Administration.

James E. Webb: President Kennedy's selection as the new NASA administrator.

When he went to work for the government at that time, Webb said, he sold all his stocks and bought government bonds. He said he will again do whatever is necessary to avoid conflict of interest. His present connections also include an assignment as assistant to the president of Kerr-McGee Oil Industries Inc., of Oklahoma City—Sen. Kerr's company, and directorships in this and several firms.

He knows Wiesner well through work with the former MIT researcher in organizing Education Services Inc., of Watertown, Mass., which works to improve high school physics teaching. He is also chairman of the Municipal Manpower Commission and director of the Transportation Research Foundation of the Transportation Association of America.

Webb served on the Draper Committee which studied the U.S. military aid program in 1958-59 and on a special stockpile advisory committee to the Director of Defense Mobilization in 1957-58. He has been an occasional consultant to the National Security Council.

While serving as Budget Bureau director, Webb instituted organization of all government research activities in a special section of the budget. This step led to the study by the John Steelman committee that resulted in creation of the National Science Foundation.

Webb also is president of the Frontiers of Science Foundation of Oklahoma. While Under Secretary of State, he introduced the practice of assigning science attaches to major embassies. ⌘

industry

KELLOGG DIVISION of American Brake Shoe Company has completed a three-month, 3000-mile move from Rochester, N.Y., to Oxnard, Calif. The move was made to consolidate the Division's activities nearer major aircraft and missile producers.

YARDNEY ELECTRIC CORP. has bought a 250,000-sq.-ft. plant from the Raytheon Company in Stonington, Conn. President Michel N. Yardney said the plant will be used to fulfill a substantial contract recently awarded by the U.S. Navy for submarine batteries and other contracts under negotiation.

WESTINGHOUSE ELECTRIC has completed its new semiconductor facility at Youngwood, Pa. The new 50,000-sq.-ft. building will be devoted primarily to the development and processing of semiconductor materials, including new forms of silicon and germanium. The company also has begun construction of its new Astroelectronics Laboratory near Los Angeles. The 25,000-sq.-ft. building will consist of an administration building and an adjoining laboratory.

JACK & HEINTZ, INC. has been merged into The Siegler Corp. through a stock exchange. J&H stockholders have the option of exchanging one share of J&H stock for 55/100 of a share of Siegler common stock, or accepting a $5.75 cumulative convertible series A preferred stock of Siegler at the rate of one share of preferred stock for seven shares of Jack & Heintz. No changes in Jack & Heintz management, employees or facilities are planned.

ERA RESEARCH INC. has been organized to manufacture and market new electronic devices for educational and commercial use. Nuclear physicist Harold Hutchinson of UCLA is president, and chief consultant is Dr. Kenneth MacKenzie, also of UCLA. The company has established executive and sales offices in New York City and Los Angeles.

APPLIED ELECTRONICS CORP. has sold a 40% interest in its former subsidiary International Communications Corp. to Electro-Science Investors of Dallas. The transaction was concluded for a reported $400,000. James J. Ling, also president of Ling-Temco Electronics, is chairman of the board of Electro-Science, a company specializing in small businesses investments.

Government Sees New Record Electronics Output in 1961

RECORD ELECTRONIC equipment outputs of $6.8 billion are expected in 1961—surpassing the 1960 highwater mark estimated at $6.4 billion.

In its annual review of the electronics market, the U.S. Department of Commerce's Business and Defense Services Administration feels that the missile/space field will provide much of the stimulus so urgently needed to offset the effect of the current recession.

The electronics industry as a whole is possibly the fastest growing unit in the U.S. economy. Output in the past 25 years has expanded 27 times compared with 5.5 times in the gross national product.

Despite the current recession, total sales excluding RDT&E of $2 billion reached an all-time high in 1960 (equipment—$6.4 billion, components over $3 billion), BDSA asserts. Further predictions indicate the 1961 output will be even higher.

The Commerce report indicates—in no small measure—the prodding effect of the missile/space field. Not only is the missile/space market increasing, but its relative use of electronics is continuing to increase percentagewise. A secondary effect is the continuing demand by the missile/space industry for new components—miniaturized, rugged, more reliable, vastly more accurate.

Growth over 1959 was roughly 10%. Only electron tube sales failed to rise (down 2%) and this of course was more than offset by the steady increase in semiconductor sales. The trend should continue in 1961, but the spread between tubes and transistors should widen more and more, BDSA says.

• **Military electronics**—The 1960 output of military systems and equipment increased about 15%, not because of a great increase in units but to an everwidening use of electronics in weapon systems and associated complexes.

R&D for such systems, the report states, increased 10% over 1959 to about $1.8 billion.

The need for more advanced systems, the steadily expanding space programs, and the increasing dependence on electronics techniques will again bring an estimated 10% increase during 1961.

It is noted, however, that even if defense obligations are increased substantially by the new administration, the effect will hardly be felt until late 1961 or 1962 because of the long lead time required to contract and schedule production.

The complexion of the market has not changed, BDSA feels. It is still an R&D market with limited production. R&D expenditures are expected to level off in 1961 but increase again in 1962 as the need for more advanced weapon systems again comes into prominence. RDT&E should reach $2 billion in 1961.

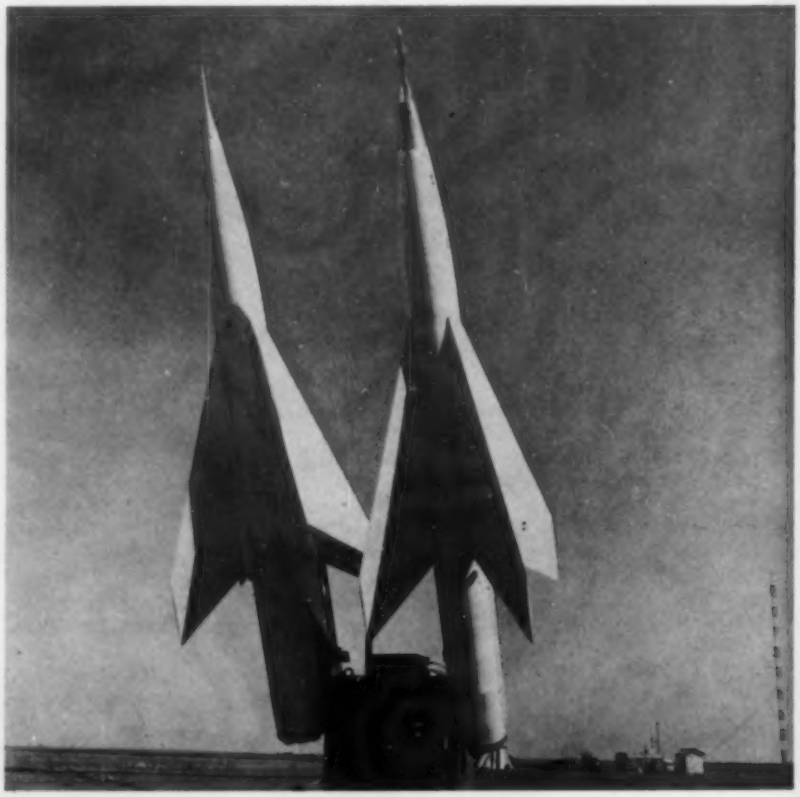
• **Commercial, industrial electronics**—Production increased in this area also by about 10% during 1960. The driving force here is believed due largely to greater capital expenditures for electronics equipment to reduce operating costs and increase efficiency. At the same time, considerable equipment was needed to support the increasing military production and RDT&E programs.

• **Other electronics**—Electron tube shipments dropped 2% during 1960. Replacement sales represent half the total and served to stabilize the market. Tube output in 1961 is expected to remain about the same as 1960, according to BDSA.

Semiconductor sales increased by 35% in 1960. Transistors amounted to $313 million; other semiconductor components reached $222 million. The dollar rise did not correspond to the unit total increase because of substantial price reductions throughout this industry segment. Estimated 1961 sales will show another marked increase—$610 million total compared with the $535 million in 1960.

Other electronic components showed about a 10% increase in sales during 1960. An increase of about 5% is predicted by the agency in 1961, reaching a total of $2 billion.

The switch to automation and modular construction at the factory plus increasing use of new techniques (such as thin-film) will have a decided effect on the overall market. ⌗



Bullpup Competitor

NORD-AVIATION reportedly has evolved an air-to-surface missile with this configuration. Called AS-30, it has Hughes guidance, is said to be cheaper than Bullpup.

BURIED BUT ALIVE

Hidden in the earth, the Air Force Minuteman missile must remain ever ready. Though untended for weeks, months, even years, each of its thousands of components must function perfectly together if the button is pushed. This is the new order of reliability being fulfilled by Autonetics – designer of the Minuteman's critical guidance and control system.

Electromechanical Systems by **Autonetics** Division of North American Aviation

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present genuine challenge to scientists and engineers of demonstrated competence

"To preserve our free institutions, it is absolutely essential that the United States find the most effective means of advancing the science and technology of space and also of applying them to military space systems. This is the mission of Aerospace Corporation."

IVAN A. GETTING
PRESIDENT
AEROSPACE CORPORATION

In accomplishing its mission, this nonprofit public service organization performs the unique role of space systems architect. Aerospace Corporation provides scientific and technical leadership to the science/industry team responsible for developing complete space and ballistic missile systems on behalf of the United States Air Force.

Specific responsibilities of the new corporation include advanced systems analysis, research and experimentation, initial systems engineering, and general technical supervision of new systems through their critical phases.

The broad charter of Aerospace Corporation offers its scientists and engineers more than the usual scope for creative expression and significant achievement, within a stimulating atmosphere of dedication to the public interest.

Aerospace Corporation scientists and engineers are already engaged in a wide variety of specific systems projects and forward research programs, under the leadership of scientist/administrators including corporation president Dr. Ivan A. Getting, senior vice president Allen F. Donovan, and vice presidents Edward J. Barlow, William W. Drake, Jr., Jack H. Irving, and Chalmers W. Sherwin.

Aerospace Corporation is currently seeking scientists and engineers capable of meeting genuine challenge and with proven ability in the fields of:

- Space booster project engineering
- Spacecraft design and analysis
- Aerothermodynamics
- Solid rocket research
- Nuclear rocket propulsion
- Ion and plasma propulsion
- Chemical propulsion
- Large scale weapons operations research
- Weapon system reliability planning
- Vehicle control systems

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A new and vital force AEROSPACE CORPORATION *engaged in accelerating the advancement of space science and technology*

Technical Countdown

ASTRONAUTICS

Balloon-Satellite Data Updated

Echo I orbital changes indicate an average atmospheric density of 1.1 x 10^{-18} g/cm at an altitude of 940 miles (with an uncertainty of a factor of 2). Allowing for orbital distortions caused by solar radiation pressure, the balloon satellite now has an estimated life of 1-2 years. Without solar radiation effects, the satellite would remain aloft about 20 years.

Weightlessness Small Problem to Soviets?

Soviet biomedics apparently feel that weightlessness is a minor problem, if a problem at all, in space flight. Their published comments on the subject reflect concern only with the psychological adjustment for the astronaut, rather than any difficulties in carrying out missions, consuming foods, or moving about in space vehicles. To help defeat radiation hazards, Russian chemists are working on a protective agent containing sulfur, albumens, vitamins, and hormones, which—when introduced into the body—is expected to increase resistance against radiation.

ELECTRONICS

Duoplasmatron Produces 1-amp Ion Beam

A duoplasmatron has been developed at the East German facility of Forschungs-institut Manfred von Ardenne, Dresden-Weisser Hirsch, capable of producing an ion beam of 1 ampere. A current discharge of 5 amperes with 60% proton content can be obtained, the East Germans say. In pulse operation, discharge currents from 20 to 100 amps can be obtained, with 85% proton content. Researchers claim that the device's efficiency in gas consumption and ion component of the drain current is almost 100%.

Superconducting Tunneling Diode Developed

A newly discovered tunneling effect—using two metal films separated by a thin insulating layer, with one or both the metal films in a super-conducting state—has been revealed by General Electric scientists. Tunneling occurs through the insulating film barrier—rather than through the charge depletion region of a semiconductor p-n junction, as in a tunnel diode.

More on Fiber Optics

American Optical has just received a large research contract from WADD to study methods for improving quality of fused fiber-optics face plates and to develop better manufacturing techniques. The plates are used in cathode ray tubes for high-speed recording of data from computers and radar receivers and in image converters. The job also includes advanced work on tapered fiber bundles for use in "ultra-high-speed photographic lens," also being developed by AO for Air Force.

PROPULSION

Freon Considered for A3 Vector Control

Polaris A3 model probably will use a freon-gas system for thrust vector control, eliminating the jetavators now used. Because the jetavators cause some obstruction of the exhaust stream, the Navy would like to eliminate them. Freon gas injected into the nozzle from selected points would serve the same purpose with improved efficiency.

JATO Bottles Re-used in Rocket Cases

Rocketdyne-McGregor is welding together used JATO rocket cases to save money in producing development cases for the Army *Roadrunner* target-missile booster. One full case and 11 inches from a second case make a case for the *Roadrunner* rocket, which produces 5500 lbs. thrust for about five seconds. The propellant is an advanced form of the ammonium nitrate propellant used in *M-34* boosters and the *KD2U* target drone. Rocketdyne reports development of the rocket is ahead of schedule. North American's Columbus Division is prime contractor.

ADVANCED MATERIALS

Tantalum Production Increases

National Research Corp. boosted its tantalum production capacity by 33%. The expansion resulted from increased demands for tantalum in the electronic and missile/space markets.

Concrete High-Temperature Limit Raised

The Russians report that they have developed a concrete capable of withstanding temperatures up to 1700°C. They say this is several hundred degrees higher than any previously known concrete could resist.

Al-Alloy Castings Approach 50,000 psi.

Investment casting methods at Precision Metalsmiths, Inc., are resulting in products of 355 aluminum alloy in the T7 condition with tensile strengths of 49,500 psi. The pieces have an elongation of 3% per 1 in. gage length. Typical tensile is 45,000 with a 4% elongation.

SUPPORT EQUIPMENT

Seaborne Launch Pad Proposed

PROP (Planetary Rocket Ocean Platform) has been proposed by Aerojet-General as a mobile site to launch nuclear rockets into trajectories or orbits which are difficult or impossible to achieve, from continental U.S. locations. Approximately 450 feet in diameter, the floating pad would be supported by an underwater buoyant chamber for below-the-surface effects of heavy waves in the open sea.

ASW ENGINEERING

Reds Mass-Produce Underwater Detectors

The Soviets have developed a small self-recording ultrasonic sounding device "for detection and delineation of underwater objects." The instrument has depth ranges of 0-45, -100, -150, and -450 meters. By employing phasing, the Soviets say, individual layers of water 50 meters thick can be inspected in the 0-300 meter depth range. The under-150-lb. device operates with a 24-v, DC input. Although they are now in mass production, there is no indication as to how many of the devices will be used, or where.

New Satellite Configuration Studied Fo

Cubic carrier scheduled for use in Transit firing
Would offer advantages for Army's precision mapping program

SAN DIEGO, CALIF.—Cubic Corp. is studying a new satellite configuration capable of carrying the transponder for the Army *SECOR* precision long-range mapping system into orbit.

A *Scout* vehicle would boost the new carrier. A mockup of the proposed satellite has been constructed by Cubic from a *Vanguard* shell. (cover)

At present, *SECOR* is scheduled only aboard the Navy's *Transit III-B* to be placed in a 500-mi. orbit by a *Thor-Ablestar*. Equipment is being delivered to the Army next month for the *Transit* shot.

But Cubic engineers say *SECOR* (Sequential Collation of Range) would gain several advantages from operation in its own satellite:

–Launching dates could be timed to meet the requirements of the system.

–Orbital inclination and orbital altitude could be selected as desired.

–Lighter weight and smaller satellites could be employed, reducing cost of the program.

The new satellite mockup seen on the cover is being used to study the weight and balance problems of the spaceborne portion of the system.

•Three known points—The *SECOR* system was developed for the Army Map Service, Corps of Engineers, primarily for the purpose of tying the coordinate systems of the various continents together accurately. It employs ground stations equipped with advanced distance-measuring equipment (DME) to measure range, on a time-shared basis, to a satellite.

When the system goes into operation with the *Transit* launch, four ground stations will be employed. Three of these will be located at known points in relation to one another. From range and time measurements, it will be possible to determine the unknown position of the fourth station.

The position of this fourth station is found by measuring its range to the satellite at several accurately known points on the satellite's orbit, as determined by the other three stations.

Cubic says the system will operate either when all four stations are tracking at the same time or when the fourth station is incapable of simultaneous tracking. In the latter case, an ephemeris is computed from the data obtained by the three prime stations.

Later, as many as six or eight stations may be employed together with additional satellites.

The first *SECOR* network will be in the Caribbean, with three of the four stations in adjoining countries—Costa Rica, Honduras and Columbia—and the fourth on the island of Jamaica.

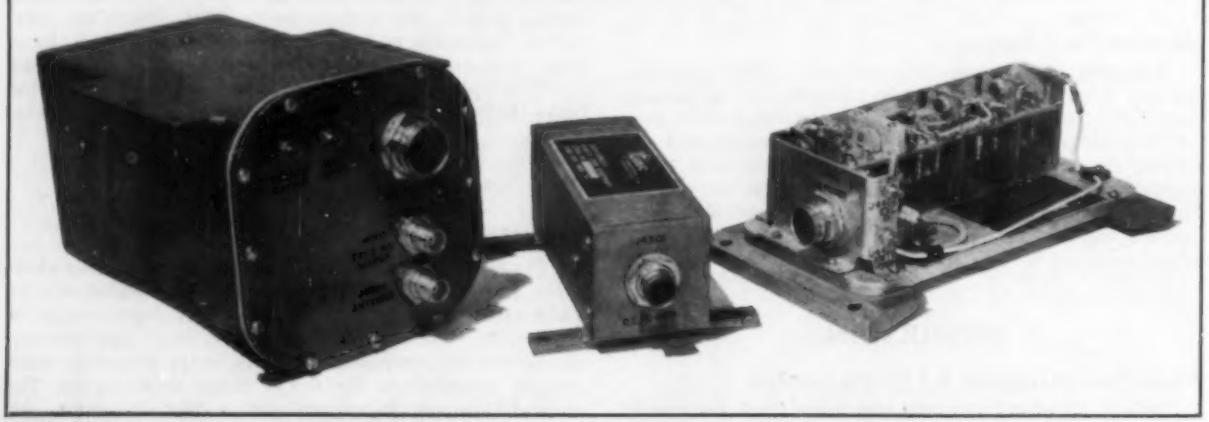
Cubic engineers say *SECOR* will make it possible to determine the position of the unknown station within a circle 10 meters in diameter. Although neither Cubic nor the Army will comment, such precise determination of positions on the earth's surface would provide valuable targeting information for the nation's ICBM's.

Each ground station will be made up of a directional antenna and two large helicopter-transportable shelters packed with electronic gear. Each shelter is labeled "Project Betty, Dept. of Geodesy." Detachable air conditioning and generator units are included.

The directional antenna in order to handle wide band is designed to geometric rather than electronic proportions. Its four baskets give it the look of old-fashioned sound locators.

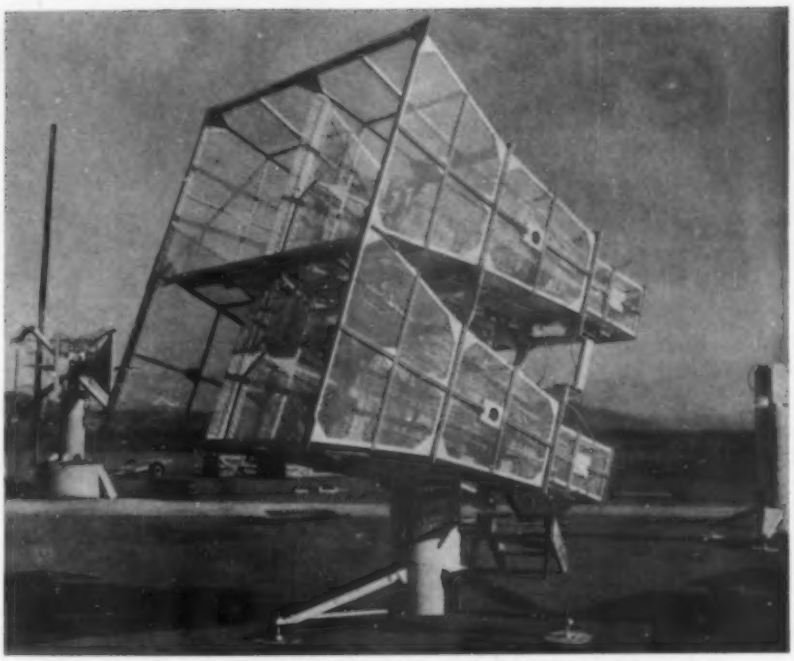
Three frequencies are employed—421 megacycles outgoing with return at 449 and 224½ megacycles. Two return frequencies are employed to correct for ionospheric refraction.

Spaceborne portion of the system consists of a 7-lb., 12-oz. transponder, containing a receiver, tone decoder, data filters, power converter and an exciter for the final power amplifier. The unit is mostly transistorized, with the exception of three General Electric ceramic tubes. At the time *SECOR* was laid out, it was not possible to transistorize the unit competely at the frequencies employed.



GEODETIC SECOR transponder and power package put together by Cubic Corp. includes a receiver, tone decoder, data filters, power converter and exciter for the final power amplifier. The unit is highly transistorized.

ed For SECOR



SIDE VIEW OF Geodetic SECOR antenna and pedestal at Cubic plant. Each ground station in the system will include antenna and two shelters for electronics.

Power aboard *Transit III-B* is supplied by the satellite's 12-volt battery.

The transponder unit aboard *Transit III-B* is carried in three packages—one, a low heat generator, inside the satellite, and the others externally beneath the solar cell belt.

Cubic has built five transponders for the present program, three for launching, one for systems checkout at Applied Physics Laboratory, and the fifth to remain in San Diego for test purposes. In calibration tests before delivery to the Army, a transponder is being flown in a Navy TV2 aircraft for operation with four ground stations situated in Southern California.

The system eventually will employ several satellites in orbit with transponders aboard. Project *ANNA*, the joint geodetic satellite, is scheduled to carry one. Selective call is provided so individual satellites can be contacted.

The air-transportable boxes making up the shelters for the *SECOR* ground station are built by York-Hoover Corp. One contains a receiver unit, high- and low-voltage power supplies, an antenna control box and the low-power end of the transmitter. The high-power portion is on the antenna.

The data-handling shelter contains three Brush Instrument recorders of two channels each with range variation and ionospheric correction. Another cabinet contains the signal receiver and equipment for making digital phase measurements.

Primary method of data handling is with magnetic tape using a digital format. Equipment used is supplied by Potter Instrument Co. Tapes from each station are sent to the Army Map Service, where they will be fed to a Minneapolis-Honeywell 800 computer.

Each ground station establishes its distance from the satellite by transmitting a frequency-modulated, continuous-wave signal which is received and rebroadcast by the transponder. During transmission the ground station records the phase shift between its transmitted signals and those received from the transponder.

The ground stations interrogate the transponder, in sequence, for 12½ milliseconds apiece with dynamic smoothing to provide the equivalent of simultaneous sightings.

An Instrument Corp. of Florida digital clock provides real time measurement within the nearest millisecond. Any station in the system can act as either master or slave. By detecting the master identification signal, other stations can set up a fixed time reference in relation to the master station.

No satellite acquisition problems are anticipated with *SECOR*. Wide-beam antennas make acquisition relatively simple, with only time and azimuth needed from the launch crew. Range of the system is given as 10,000 mi. ⠿

Host of Firms Show Interest in NASA's Relay

FORTY-ONE COMPANIES are interested in bidding on the Project *Relay* communications satellite for the National Aeronautics and Space Administration.

NASA originally invited 20 companies to its briefing on the contract, originally scheduled by the Goddard Space Flight Center, Greenbelt, Md., for Jan. 4 and 5 (M/R, Jan. 9, p. 13).

However, many others asked to be represented and 41 appeared at the briefing Jan. 24 and 25. The full list follows:

AT&T, General Electric Missile and Space Vehicles Division, Lockheed Missiles and Space Division, Philco Western Development Laboratories, Ford Aeronutronic Division, Republic Aviation, Avco Research and Advanced Development Division, Western Electric Radio Division, IT&T Federal Division, IT&T Kellogg Division, Bendix Systems Division, Hughes Aircraft, Motorola Western Military Center, RCA Astro-Electronic Products Division, The Martin Co., Collins Radio, General Dynamics Convair Division, Page Communications Division of Northrop, North American Missile Division.

Also, Grumman, McDonnell, Loral Electronics, General Dynamics' Stromberg-Carlson Division, General Telephone & Electronics, Melpar, Sperry Gyroscope, Telechrome Manufacturing, H. R. B. Singer Inc., Watkins-Johnson, Northrop Radioplane Division, Raytheon Aerospace Division, Airborne Instruments Laboratory, Dumont Military Electronics, Hoffman Electronics, IBM, W. L. Maxson, Minneapolis-Honeywell, Space Electronics Corp., Electronic Communications, Lyons Transdata and STL.

Bids are due by March 6.

NASA to Set up Staff For Theoretical Research

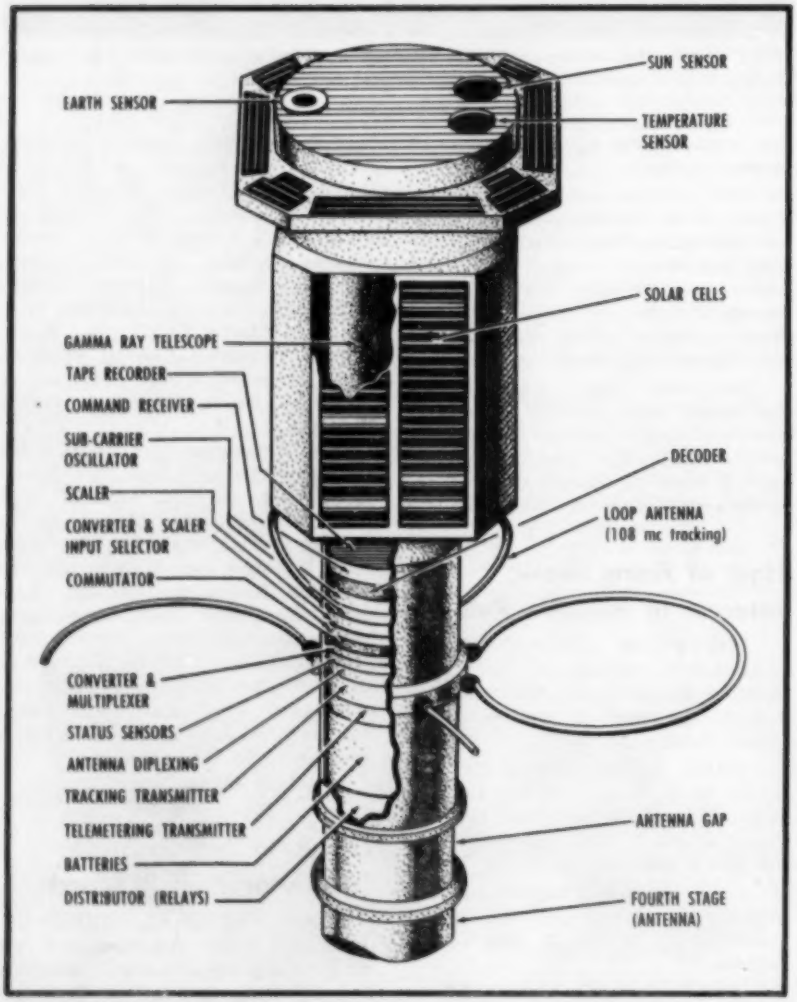
THE NATIONAL AERONAUTICS and Space Administration will establish a group of about 50 scientists and supporting staff in New York City to conduct theoretical research in astronomy and space sciences.

The office site has not been chosen. ⠿

S-15 May Solve Cosmic Ray Riddle

NASA shot due by March 31 will use gamma-ray telescope to search below inner Van Allen belt; MIT, Raymond Engineering Lab involved in "most complicated" test

by William Beller



CUTAWAY DRAWING of 85-lb. gamma-ray payload, showing circular strut assembly that fits into third stage of Juno II, the cross-loop antenna for tracking and reciving, and the solar-cell assembly encasing the payload.

A MAJOR STEP in astronomy-from-a-space-platform is planned before the end of March—a search of the sky with a gamma-ray telescope orbiting below the inner Van Allen belt.

Gamma rays, like X-rays and light rays, are electromagnetic radiations. Their frequencies correspond to very-high-frequency X-rays.

Results of this experiment could answer the 60-year-old question of where cosmic rays come from. A lesser but still formidable ambition is to get a gamma-ray map of the sky. The experiment is said to be the most complicated ever tried in a satellite.

As with cosmic rays, nobody knows where the sky's gamma rays come from. The chief surmise is that they result from the interaction of cosmic rays with galactic gas. Hence for the time being they are termed "galactic secondaries," analgous to the cosmic ray secondaries formed when cosmic rays impinge on atoms of the earth's atmosphere.

• **Inside the payload package**—A *Juno II* space vehicle will put the 85-lb.-gamma-ray payload—*"S-15* satellite" is the National Aeronautics and Space Agency's designation—into a hoped-for circular orbit. The payload is built onto the spin-stabilized fourth stage of the *June II* system.

Nickel-cadmium batteries recharged by solar cells will be giving electrical power to the payload. The satellite's scientific life is expected to be one year.

Similar to the *Explorer* series of satellites, the *S-15* is a two-antenna system. The cross-loops are for tracking and command receiving. The split dipole—divided by the antenna gap on the fourth-stage rocket—is for data transmission only.

The *Vanguard*-satellite type construction is used for the instrumentation column. Thus, foam-podded, 6-in.-diameter cylindrical pies—each one serving a different housekeeping or electronics function—are stacked one on top of another like checkers. The system can be assembled as easily and be as reliable as any modular structure.

The gamma-ray telescope is a scintillator plus a Cerenkov counter; and these are in coincidence to detect the gamma rays and also to reject spurious events.

The telescope has a broad field of view of about a 30° solid angle. It can

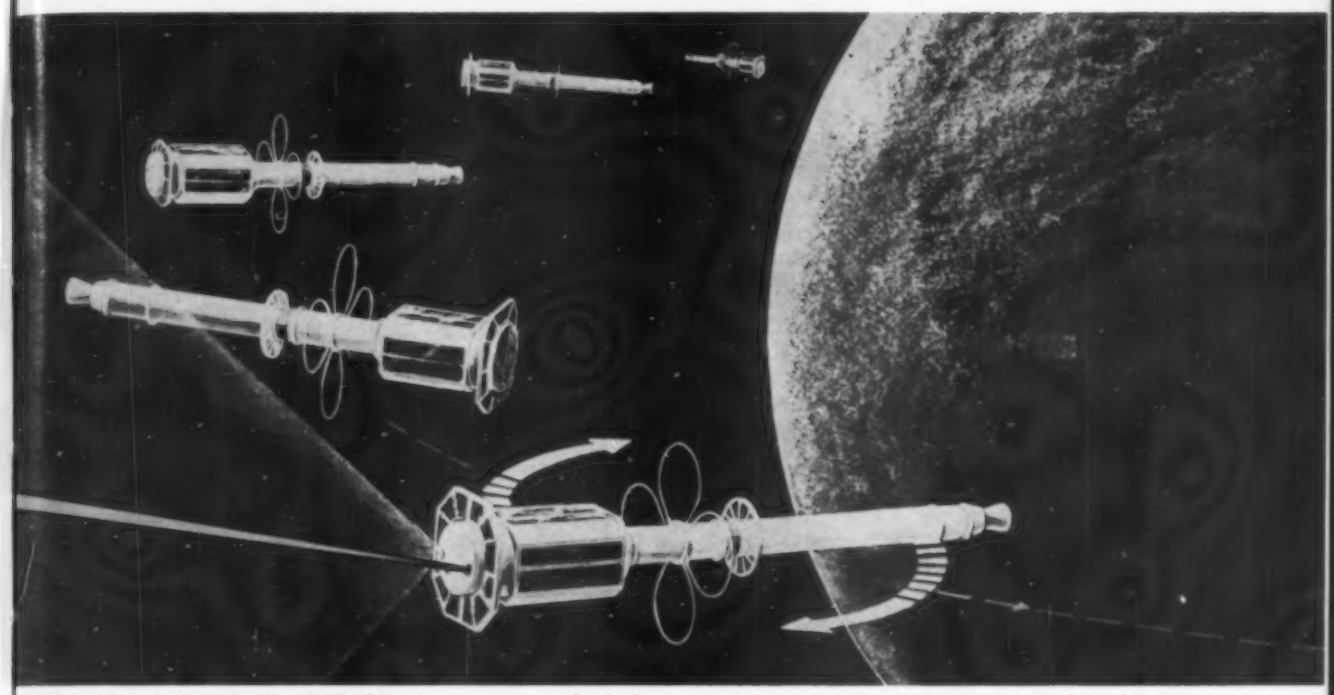


DIAGRAM SHOWS TRAJECTORY of gamma-ray payload about its maximum-moment-of-inertia axis at about 10 rpm.

measure gamma rays with energies of 100-million electron-volts and up. Most of the ray energies are expected to fall between 100-million and 400-million electron-volts.

This gamma-ray work is a Massachusetts Institute of Technology experiment funded by NASA. Principal MIT investigators are Professor of physics William Kraushaar and Associate Professor of physics George Clark.

The Marshall Space Flight Center in Huntsville, Ala., designed the payload except for the telescope, which is an MIT design and the tape recorder, which is the design of Raymond Engineering Laboratory, Middletown, Conn., and Goddard Space Flight Center, Beltsville, Md.

Marshall is also doing the payload integration and testing, and will be responsible for the launching.

Goddard will be tracking the *S-15*, acquiring the data and reducing them. Subsequently, the MIT investigators will analyze the information.

Other companies involved include the Electronics and Ordnance Div. of Avco, which made the command receiver; and Texas Instruments, which built the commutator and the converter and multiplexer.

• **Almost an impossible project**—About a year and a half ago the chances of sending up the gamma-ray telescope looked dim from a technical standpoint. Here's why: the spin-stabilized upper stage of the *Juno II* was designed to rotate at about 400 rpm. For telescopic observations, this was far too fast. In addition, the forces induced by this speed were too high for the relatively delicate instrument to resist for long.

There were thoughts of using reaction jets or some other such control measure to slow down the rotation. These were looked upon with little enthusiasm because of the design and reliability problems they would bring with them.

At this point, Marshall scientist Dr. Charles A. Lundquist made a brilliant observation and thereby solved the problem. He said that because of the inherent instability of the rocket stage rotating about its thrust (minimum moment of inertia) axis, the rocket would eventually rotate about its axis of maximum moment of inertia with a consequent despin.

In this way, Lundquist indicated that nature would accomplish for the designers what they were contemplating doing mechanically. The spin rate would eventually be reduced by the transfer of momentum from the minimum-moment-of-inertia axis to the maximum-moment-of-inertia axis.

For the *S-15*, the ratio of the two moments of inertia is about 40. Therefore, the 400-rpm rotation about the thrust axis is reduced to 10 rpm about the maximum-moment-of-inertia axis, which is a tolerable design value for the telescope.

Also, 10 rpm now becomes the rate at which the telescope will scan the heavens. This means that once every six seconds the telescope will make a complete transit of the sky.

• **Getting a fix on the** *S-15*—In one very important instance the *S-15* is unique. Its orientation with respect to the celestial sphere will be known at all times. Presently, a satellite's position is known only as an angle with respect to the sun.

The orientation method was devised by Goddard's Dr. James E. Kupperian, Jr., head of the astrophysics branch. It involves two sensors. One is a relatively insensitive one for the sun; its field of view is large, 170°. The other is a relatively sensitive sensor for the earth; its field of view is only 15°.

From the combined outputs of these sensors, a computer can calculate the orientation of the satellite's spin axis to an accuracy of about five degrees.

The orientation of the spin axis will change slowly. It will change under the effects of solar radiation pressure, the earth's magnetic field, atmospheric drag and gravitational torque.

Ideally, the experimenters want a circular orbit below the Van Allen belt for their satellite. The Van Allen belt if penetrated would contribute only background noise that would have to be rejected, maybe to the failure of the experiment.

Kupperian points out that this is the beginning of gamma-ray astronomy in space. ⌗

Price of Inadequate Measurement Standards

AIA-sponsored conferences find that lack is hurting defense effort; NBS moves to increase services

CONFUSION, EXCESSIVE delays and loss of money are the penalties both industry and national defense are paying for a lack of national measurement standards adequate to the Missile/Space Age.

This is the conclusion reached by a series of measurement research conferences conducted by the Aerospace Industries Association's Quality Control Committee, with the cooperation of the National Bureau of Standards.

These conferences, by providing a forum for exchange of ideas, have brought about a better understanding of the limitations under which measurement experts operate both in industry and at NBS. In some cases, the Bureau decided after the talks to make some program changes; these will soon result in additional calibration services.

More meetings are planned. The next series, to be held at the NBS Boulder (Colo.) Laboratories, will deal with radio frequency measurement problems. A series of meetings on shock, vibration, force, and acceleration is tentatively scheduled for April. Other areas are due to be covered during the summer.

• **Microwave power and attenuation**—The first two meetings, held at Boulder in May, 1960, dealt with microwave power and attenuation measurements. Underlining needs in this area, an industry representative described million-dollar development of radomes which had to proceed more by trial and error than by test and analysis, because there are no precise phase and amplitude measurement capabilities in the required frequency range.

Another conferee cited the practice of over-designing Klystron tubes—devices used to generate high-power signals for radar detection systems—to insure that the tubes are powerful enough to do the job. Techniques for accurate measurements of peak microwave power would make this costly procedure unnecessary.

For these and some of the other needs it discussed, the meeting saw no immediate solutions. In other cases, however, interim solutions were suggested and are being adopted. For example, calibration, services for waveguide power measurements in the frequency range 3.95-8.2 gc and coaxial power measurements in the frequency range 300 mc to 12.4 gc will soon be made available at NBS—although these will be somewhat less accurate than will ultimately be necessary.

• **Internal diameters and surface finish**—The second group of meetings, at the Bureau's Washington laboratories last June, was devoted to problems faced by industry in measuring internal diameters and surface flatness and finish.

The miniaturization imposed by space limitations in missiles and aircraft has caused a reduction in hole sizes, and the resulting calibration demands are in ranges lower than NBS can presently handle.

During these meetings it also became evident that inertial guidance systems—and such developments as the use of gas bearings—have created requirements for extremely close tolerances. One industry representative contended that if there were measuring techniques to permit holding the tolerances on bores and bearings to 10 microinches, the cost of a large-quantity production item could be reduced from $950 to $250. In the case of another item, because of inadequate accuracy in measuring hole sizes, three $25,000 units must be constructed for every good one produced.

At this meeting, the industry representatives made a strong plea, for a research effort at NBS looking toward development of standards and measuring techniques based, if possible, on entirely new concepts—since old methods cannot provide the ultra-precise gaging necessary to the interchangeability of parts so essential in modern industry. At present, industry is being forced back into the medieval concept of hand-craftsmanship.

During the discussion of surface finish measurements, the problem of noisy gyroscopes was cited. This type of faulty operation is believed to be

EXPERIMENTAL tantalum tube high-temperature furnace is used to calibrate refractory metal thermocouples at temperatures above 2000°C. Lack of standards for extremely high temperature measurements is a critical problem in space technology.

associated with surface finish characteristics, since changing bearings or other frictional surfaces usually corrects the difficulty. With existing standards and techniques it is not possible to measure surface characteristics accurately enough to eliminate defective components prior to assembly.

Such trial-and-error methods are extremely costly in time and money.

As a partial solution to this problem, the Bureau plans to offer a calibration service for physical roughness standards, although the initially available accuracy probably will not meet all needs.

• **Gears**—The fifth meeting, in September, covered the problem of gear calibrations and measurements. Limitations in the use of master gears as standards were recognized; but this appears to be the only technique presently available for small gears. Industry representatives urged that NBS acquire the facility to provide a calibration service for such gears, and simultaneously organize a strong research program to develop better methods for standardizing gear measurements.

One industrial representative reported that in the first six months of 1960 the cost of gears rejected by his company exceeded $54,000. This was the direct result of the absence of standard gear masters. In addition to these obvious losses, the company, because the high rejection rates resulted in sporadic deliveries, was forced to work its production facilities overtime at premium pay to fill orders.

• **Infrared, temperature and humidity**—The most recent series of meetings, last October, dealt with these measurements.

The need for specification of a "standard wet atmosphere" as a basis for evaluating the performance of infrared systems was stressed by several industry representatives. Attempts to get agreement between users and suppliers of infrared equipment have run into serious difficulties because of the lack of agreement on test conditions. It was urged that the Bureau's current work in determining the molecular absorption properties of atmospheric constituents be continued at a high level as an effective contribution in this area.

Programs in which radiometric measurements and decisions based on them must be made from satellites were cited as costly undertakings, the success of which is being periled by the lack of sufficiently accurate measurements and standards. Conferees observed that several military systems are operating with less than desirable reliability because decision-making functions are based on infrared measurements of inadequate accuracy.

Although the NBS program in temperature measurements and standards has nearly doubled in the last five years, it still is inadequate, industry members charged. In cryogenics, extensive industrial use is being made of superconducting circuits and of cryogenic inertial reference systems. Temperature measurements with ever-increasing accuracy are required.

Exemplifying measurement problems in the intermediate temperature range, an industry representative said, is the necessity for precise temperature control within gyroscopes used in certain inertial reference systems. The system accuracy is strongly affected by the accuracy with which the temperature sensing and controlling elements function to maintain uniform performance of the gyroscope.

In the very-high-temperature region more accurate measurements are needed in the study of materials suitable for rocket throat lining. Rocket design engineers feel that they are badly handicapped in their efforts to improve the design of rocket motors because standards and techniques for the measurement of exhaust gas temperatures are essentially non-existent.

The costs of improper design in this area are large. For example, the cost of fuel alone in a single test firing of a certain rocket was given as $125,000. The fact that even a small reduction in measurement uncertainties would reduce the number of test firings was repeatedly stressed.

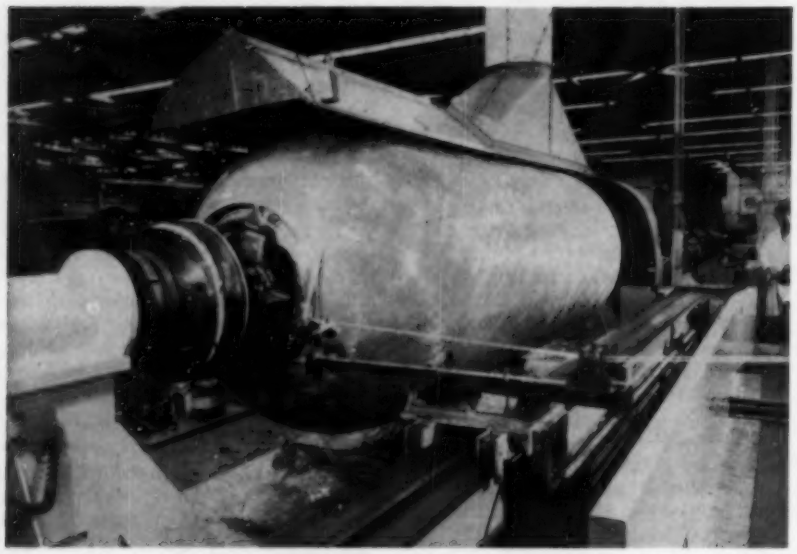
One industry representative described an abort maneuver navigational system, for a glide-type re-entry vehicle, based on temperature measurements. He reported to the group that while the proposed technique appeared very attractive from every other consideration, it had to be abandoned—at the cost of increased complexity and reduced reliability—because temperature measurements could not be made accurately enough.

It was pointed out that, in many applications, not having sufficiently accurate temperature measuring techniques actually costs far more in terms of months before checkout than in terms of dollars, although it is seldom possible to arrive at a definite estimate of the time factor.

The meeting heard two examples of how weight in a missile system was reduced through a limited increase in the accuracy of temperature measurements. In one case, reduction of the uncertainty from 10° to 2°F effected a savings of 250 lbs. with a substantial improvement in range. In the other, it was demonstrated that improved temperature measurements available for determining the thermal conductivity of a heat shield would permit saving 125 lbs. in the payload, which was translated into 12,500 lbs. in the complete system. Although accurate data on cost per pound for such a system were not available, possible savings were estimated at many thousand of dollars. ¤

PLAIN CYLINDRICAL ring gage is measured with commercial machine that checks inside diameters of holes as small as .017 in. with accuracy of a few millionths of an inch. Lack of suitable ID measurement techniques is a major difficulty in production of precise devices.

Boeing Experiments With Glass Fiber Tanks



DUAL COMPARTMENT liquid fuel tanks are being wound from glass fiber filaments at Boeing Airplane Co. The experimental development is being conducted under a $100,000 contract from the Air Research and Development Command.

The tanks measure 6 ft. in diameter and 21 ft. in length. Each holds 3100 gallons and is designed to withstand a pressure of 665 psi. The vessels are lined with a special aluminum foil and plastic sheeting developed by Boeing. This liner prevents rocket fuel from dissolving the bonding agents used in forming the filaments.

The dual compartments are for fuel and oxidizer. The rocket engine with which such tanks could be used was not identified. Boeing is also considering ceramics as materials for the winding process. Principal advantages of the process are in cost and weight reduction.

GWU Offers First Classes In Measurement Science

CLASSES IN MEASUREMENT science, the first offered in this country, begin this week at George Washing University in Washington, D.C., mark a growing recognition of the importance of metrology in the missile/space industry.

The National Bureau of Standards will provide all laboratory facilities for the classes until GW can equip its own facilities.

Part of the expenses of the Center for Measurement Science will be borne by "associates" — individuals, firms, government agencies—who contribute $5000 annually to the Center. In return, the Center will provide the associates certain privileges including consultation and technical service on their measurement problems. Martin-Baltimore has already become an associate; Aerojet-General and Weinschel Engineering have expressed interest in the program and the latter is supplying an instructor. One large machine manufacturer is contemplating a substantial gift of equipment.

Acting secretary of the Center is W. J. Mayo-Wells, assistant professor of electrical engineering at GW. #

Telemetering Group Shapes Committee on Standards

THE NATIONAL TELEMETERING Conference has completed the groundwork in its organization of a long-sought and badly needed committee to coordinate telemetering standards. A. E. Bentz, of Sandia Corp., has been named chairman. Full committee membership and subcommittee assignments are expected to be announced soon.

Memberships will include technical representatives from the four groups involved in telemetering: missile ranges, missile manufacturers, telemetering equipment manufacturers, and government agencies. There will be seven members from industry, seven from government and one representative from each of the engineering societies included in NTC (IRE, ISA, IAS, ARS, and AIEE).

The committee will serve as a focal point for reception, coordination and dissemination of information and will recommend and endorse standards, methods, and procedures to users, manufacturers and supporting agencies. Specifically, the group will determine what telemetering standards are in existence and planned, their technical adequacy, and the need for additional standards. It will also establish such new standards as are needed. #

AF Seeks Fiber to Replace Nylon in Some Space Roles

THE AIR FORCE is searching for a fiber to replace nylon for use in decelerators, manned satellites and space suits.

Nylon's low melting point, 484°F, eliminates it from certain space applications where temperatures in the order of 2500°F are expected.

Scientists at the Air Research and Development Command are investigating fibers made of gold-plated tungsten and molybdenum, glass, ceramics, super alloys and other materials.

The fibers are developed by contractors from industry and sent to ARDC's Wright Air Development Division, Dayton, Ohio, for evaluation. Properties such as tensile strength, stretchability and energy absorption are high on the list.

One basic problem lies in achieving fine diameters—0.0002 mil across. Since resilience increases as the diameter decreases, the finer the better. Fibers of this type can be twisted together to give any cloth woven from them resilience, flexibility and tear strength.

LMSD Uses Mylar for Experimental Antennas

LIGHTWEIGHT ANTENNAS fabricated from clear Mylar film and Mylar-reinforced aluminum foil inflatable from compact packages are under development at Lockheed Missiles and Space Division.

The experimental antennas were fashioned for the Air Force's Wright Air Development Division specifically for space applications.

Designs include a six-foot sphere, a conical spire, the log-periodic and fan beam. The first is highly directive for point-to-point communication. The spire and log forms are designed for wide coverage of the globe and the fan beam is a compromise between the wide and narrow beam.

Said Gaspard de Coriolis: *"A particle which is subject to no forces in a rotating coordinate system experiences a radial acceleration and a tangential acceleration."*

It was around 1840 that Coriolis discovered what has since become known as the Coriolis Effect. He noticed objects above the earth tend to rotate relative to the earth's rotation . . . to the right in the northern hemisphere, to the left in the southern.

The Coriolis Effect is in force in outer space, too. If a space vehicle is rotated in order to establish artificial gravity, the necessarily short radius of the rotation causes a Coriolis force. This creates orientation problems for a human occupant. To eliminate this difficulty, a scientist at Lockheed Missiles and Space Division conceived the idea of connecting the vehicle to an auxiliary fuel tank by a half-mile-long cable. Thus, if the whole system is then rotated at a reduced speed around its center of mass gravity, the longer radius greatly minimizes the Coriolis force. Right now—on the drawing boards at Lockheed—is an enormously advanced space vehicle system which utilizes this concept, in addition to many others.

Fortunately, natural laws are about the only restrictions which circumscribe scientists and engineers at Lockheed Missiles and Space Division. The climate in Sunnyvale and Palo Alto, on the San Francisco Peninsula, is close to perfection. The creative atmosphere—the opportunity to work on such important projects as the DISCOVERER and MIDAS satellites, the POLARIS FBM, or even more advanced concepts such as the space system cited above—is the dream of the creative engineer.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-11A, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

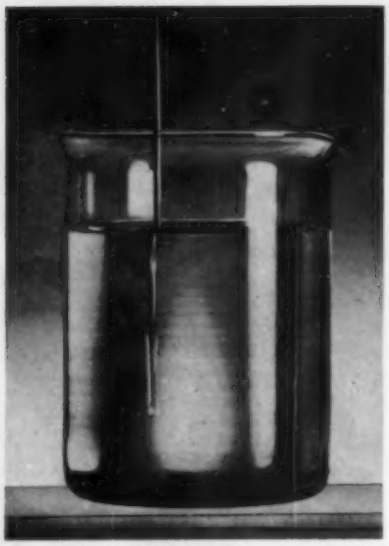
Special Gages Will Record Strain on Dyna-Soar

Device made by Microdot has been tested in half-dozen major programs; electronic spot welding is feature

PASADENA, CALIF.—Measurement of strain on *Dyna-Soar* during flight will be made by special strain gages electronically welded to the craft's surface in numerous locations. The gages have been proved out on the *X-15* program and are slated for use in several other systems.

Microdot, Inc., producers of the device, utilize several unique construction and welding techniques to achieve the characteristics which make the gage desirable in extreme-environment applications. Typical of programs now using the gage are *Titan, Minuteman, Polaris, Sergeant, Pioneer, Discoverer* and various research programs on high-temperature creep, supersonic sleds, nuclear reactors and wind tunnels.

The gage consists of a length of Evanohm wire encased in a stainless steel tube. The wire is tapered by an exclusive process from .007 in. to .001 in., its small size chosen for high resistance advantages. Insulated by magnesium oxide, the wire touches no part of the steel tube. The insulating medium completely fills the tube, and possesses excellent resistance to ground at high temperatures.



CAPABLE of operating in various liquids, the gage is used in corrosive fluid tanks to detect action of fluid on tank.

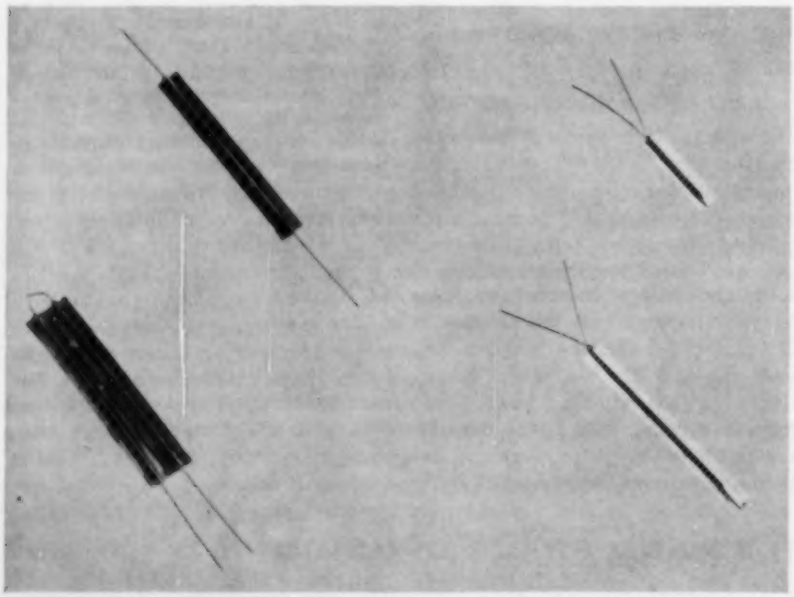
The series of gages in the Microdot line can measure strain to 5000 micro-inches and above. Temperatures in which the gage will operate stretch from –320°F (liquid nitrogen) to 750°F static or 1500°F dynamic. Temperature compensation eliminates necessity for a dummy gage at temperatures below 750°F. During operation, the gage can be accidentally smashed flat without causing a short circuit.

Electronic spot welding to the surface to be monitored is a capability of the gage which has attracted most interest among extreme-environment-test conductors. Welding is done by a "Rollectrode" operating on 24 vdc. A powered wheel designed for optimum spot weld spacing can be angularly rotated and locked in any position for attaching gages in tight spots.

The replaceable wheel is operated by a 12,000-rpm motor, geared down to one rpm at the electrode. A powered wheel is used because a free wheel would tend to stick. The Rollectrode is compatible with any capacitor-discharge welder.

A sector wheel equivalent to one gage length is also available for the Rollectrode to provide ease of welding in confined areas. Two button switches on the unit start and reverse the wheel.

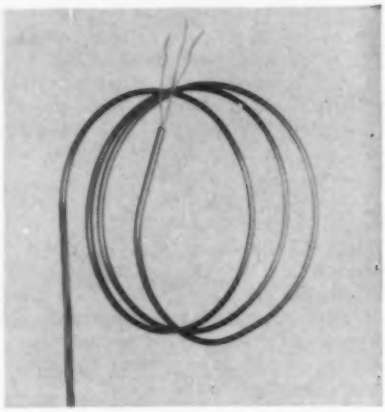
Gages are weldable to steel, aluminum and other non-ferrous and ferrous metals, and are unaffected by radiation fields. Gage size is variable, with length of either 9/16 in. or 1 5/32 in. and widths of 1/4 in. or 1/8 in. available. Height is .020 in. ⌗

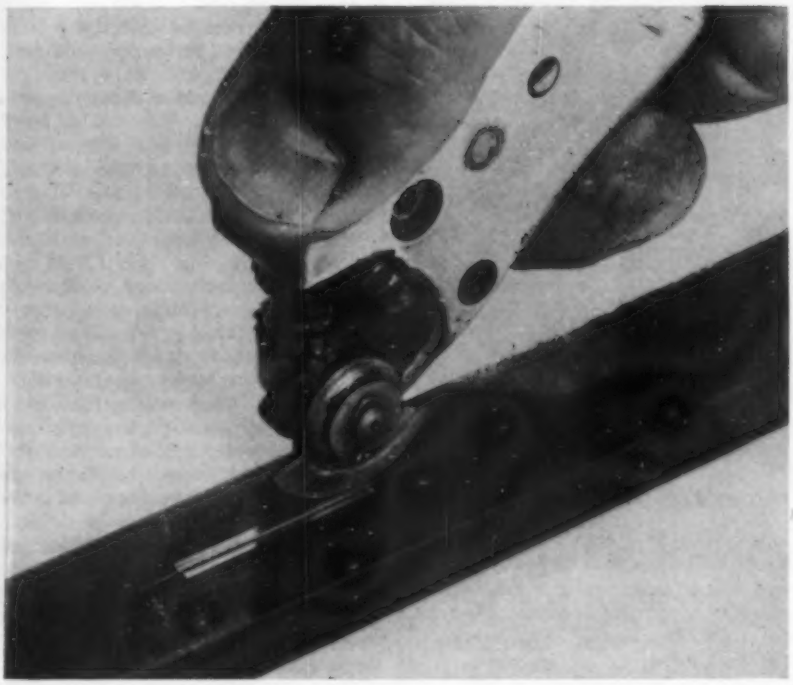


ELECTRONICALLY WELDABLE strain gages for use on the Dyna-Soar are selected from a variety of types, depending upon the requirements of the measurement. Both 60- and 120-ohm resistance types are illustrated here.

ABOVE: *The Rollectrode in operation with its powered wheel. The wheel is one gage length in circumference and spaces spot welds at optimum distances while operating at one rpm. The motor, geared down by planetary gears, operates at 12,000 rpm on a 24 vdc power supply.*

BELOW: *The Rollectrode sector wheel for use in confined space permits the operator to achieve maximum use of the tool. The wheel can be angled and locked in any position during welding.* **RIGHT:** *Some gages can be equipped with an integral lead of stainless steel fused to the gages outer tube. The unit is then heliumtested for leaks and can be immersed in corrosive media. Resistances of 60 or 120 ohms can be provided in the design.*





PMR Facilities

Acoustic Chamber and Centrifuge Are Added

AN ACOUSTIC TEST chamber and a 32-ft.-diameter centrifuge have been added to the rapidly mounting list of test facilities available to Pacific Missile Range.

The acoustic chamber can produce sound pressures up to 156 db. It may be used to generate specific frequencies or reproduce tape-recorded sounds of actual missile firings or other events which can be used as inputs for studies of specific problem areas. Included in the system are 32 large electromagnetic speakers and three large air-driven speakers, each as powerful as 750 average "hi-fi" speakers. The three large units may use as much as 200 cubic feet of air per minute during high-level operations.

Personnel of the acoustics laboratory plan to record and measure sounds of missile operations at Point Mugu Naval Missile Center and other PMR installations, and duplicate them in the chamber for test of fully assembled small missiles or subassemblies and components of larger missiles.

Some studies of the human body's stress limits are planned for the chamber. The acoustic facility, located in PMR's new Environmental Simulation Laboratory, was designed by engineers and the Naval Missile Center and built by the Center's Technical Support Directorate.

The 32-ft. centrifuge is said to be the only one of its kind. Also designed at NMC by the Environmental Applications Branch, the device is simply a large turntable driven by multiple hydraulic motors at the table's rim. The large surface area permits test of equipment at simulated high altitudes.

Rim speed of the centrifuge is over 150 mph with a capacity of 50,000 gravity lbs., equal to a 1000-lb. load at 50 g.

A counterweight is required for test packages on the turntable. This may be either another test package, equipment for special environmental conditioning of the test package, or a dead weight. The design includes considerations of this approach—in effect, doubling the device's capacity.

There are also provisions for loading the big centrifuge from an auxiliary disc to simulate sudden acceleration of a stationary object.

NMC's Technical Support Directorate also built the centrifuge, located in the Environmental Simulation Laboratory. Full operation is expected by mid-year, but the acoustic test chamber is already in operation. ⠿

Marshall Center Seeks Wings for Saturn Landing

WERNHER VON BRAUN'S engineers have decided to try to develop wings for *Saturn* so it can be recovered on dry land.

Von Braun's Marshall Space Flight Center has awarded two contracts totaling $315,827.91 for study of a paraglider recovery scheme put forth by a scientist at another research center of the National Aeronautics and Space Administration.

The Marshall center awarded six-month contracts of $170,000 to North American Aviation's Missile Division and $145,827.91 to Ryan Aeronautical. At the same time, Marshall confirmed that it has cut back its contract with Cook Electric for development of a parachute-borne water recovery method, because of the time and expense involved in reconditioning the 100,000-lb. booster after immersion in salt water.

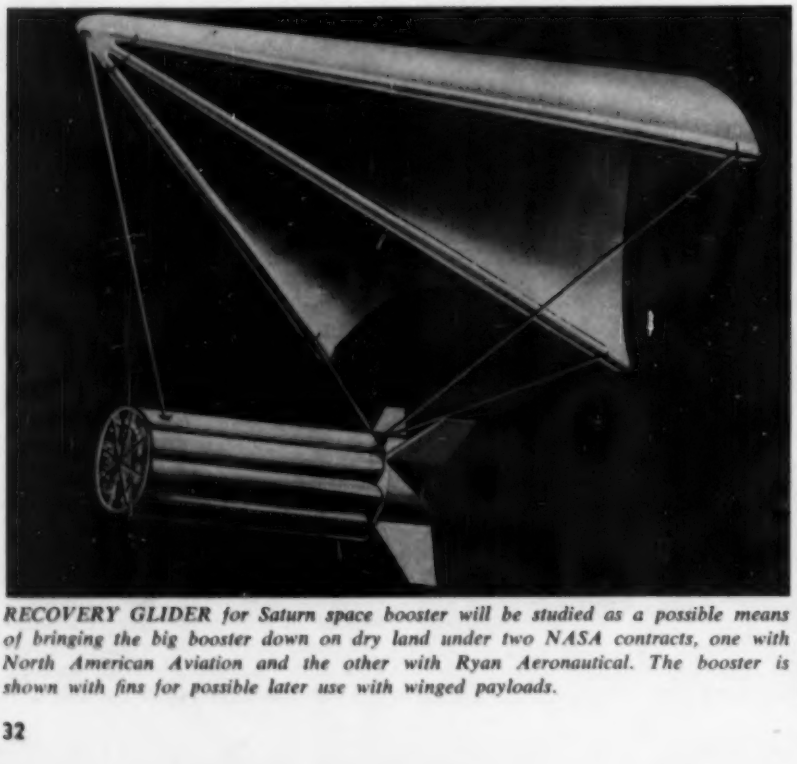
The paraglider recovery plan for *Saturn* was developed by Francis M. Rogallo of NASA's Langley Research Center. It calls for lightweight flexible wings that would be folded longitudinally before release between the outer booster tanks. They would be triangular shaped and connected in tandem. As the booster returns to the atmosphere from space, air flow would open the wings, just as it opens a parachute. Hence the name paraglider for the projected recovery system.

The North American and Ryan studies will also take up problems of glide control, deployment and landing systems, to work out ways of getting the booster back to dry land after it is released.

No effort will be made to recover *Saturn* boosters in early flights. The studies will also make a preliminary investigation of feasibility of recovering the *S-II* stage, the 800,000-lb.-thrust liquid hydrogen vehicle that will be used on *Saturn* C-2.

• **Fins for Saturn?**—Still another question raised in the studies will be the problem of adding fins to the *Saturn* booster in the event it is used to launch winged payloads. The Air Force found it necessary to redesign *Titan* by adding fins to increase aerodynamic stability on the upward flight when carrying *Dyna-Soar*. If the NASA *Apollo* should have wings for re-entry, the question then arises whether to add fins to the *Saturn* booster.

The previous booster recovery method planned for *Saturn* called for alignment of the booster with hydrogen peroxide jets before re-entry, followed by the use of an inflatable drag cone for stabilization. Then a parachute system would have slowed it and retrorockets would have slowed it further just before hitting the water. ⌗



RECOVERY GLIDER for Saturn space booster will be studied as a possible means of bringing the big booster down on dry land under two NASA contracts, one with North American Aviation and the other with Ryan Aeronautical. The booster is shown with fins for possible later use with winged payloads.

Solid Savings

Switchover in Booster Fuel Urged by Geckler

SALT LAKE CITY—Shifting from liquids to solids for space vehicles in the *Saturn* and *Nova* class would save at least 30% in cost, an Aerojet-General executive declares.

Richard D. Geckler, vice president and general manager of Aerojet's Solid Rocket Plant at Sacramento, told an American Rocket Society meeting last week that a segmented solid rocket system could be ready by 1964. Every payload from *Atlas* to *Nova* size could be carried by the segmented solid rocket, either single chamber or clustered, he asserted.

No further progress in the state of technology is needed to bring the large solid-propellant booster to reality, Geckler added. "We propose to construct the segmented system along design lines already well proven in large solid rocket programs. We will not seek the ultimate in performance, but rather the ultimate in reliability."

While the Aerojet executive confined his remarks to the segmented booster, some others in industry, particularly in Thiokol Chemical Corp., are proposing the large one-piece solid rocket, cast at the launch site or transported by barge, as the solution.

Geckler estimated that it will cost $15 million to launch a four-stage *Saturn C-2* of the currently planned all-liquid design. If a solid booster were substituted, he said, the cost would fall to $8.5 million. He said the 45% saving would be achieved by using a 140-in. single-chamber segmented solid first stage.

Similarly, the cost of launching the proposed *Nova* vehicle would drop from $60 million to about $38 million a copy, Geckler continued. He maintained that the segmented solid rocket in the *Nova* class could be ready by 1964, four years ahead of a liquid vehicle.

Aerojet-General, which is doing a feasibility study of large solid propellant units for the Air Force, has conducted preliminary design analyses of segmented solid rockets as Jato units for *Atlas* and *Titan* boosters. (The Russians reportedly have done something similar to boost the load-carrying capacity of their big space booster.)

Two segmented boosters as Jatos would add 200,000 lbs. of takeoff weight but would double the thrust of an *Atlas* or *Titan* and would add 4000 lbs. to their payload in a 300-mile orbit, Geckler declared. The cost per lb. of added payload would be 30% less than the cost of the original payload. ⌗

Alinement for Minuteman-on-Rails

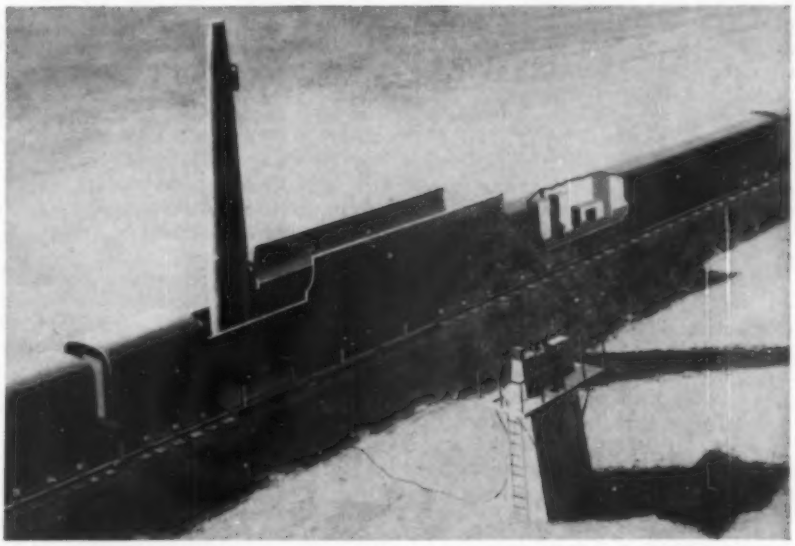
Autonetics' developed unique system for optical alining which is built into the missile itself

by Richard van Osten

OPTICAL ALINEMENT of the *Minuteman* guidance package is one of the more difficult design problems encountered in basing the solid-fueled ICBM aboard trains.

First details of the mobile system were disclosed at a recent Development Engineering Inspection (DEI) in the Seattle plant of Boeing Airplane Co., prime for the program. It differs radically from the hardened, silo-based system—where a small gallery is provided at one side of the silo's northeasterly upper section for autocollimating and other alinement equipment.

To duplicate this system on a train, it would be necessary to carry around a large tower. This would hardly be practical. Hence the Autonetics Division of North American Aviation developed a unique alinement system which is built into the missile with readout in the guidance and command car.



ARTIST'S CONCEPTION of the Missile Alinement Set (MAS) for the trainborne Minuteman being calibrated at a Missile Unit Support Base (MUSB).

Autonetics designed and built the entire Trainborne Operational Equipment (TOE), of which the alinement system is a part, used with the mobile concept. (M/R, Jan. 16, p. 35). The division also is the associate contractor for airborne portions of the guidance and control (G&C) system. Most of the TOE system was developed by Autonetics' Computers and Data Systems Div., headed by Dr. Norman F. Parker.

Designated the Missile Alinement Set (MAS), the alinement equipment is permanently installed in the missile car.

To speed up missile alinement, an accurate base azimuth is supplied by a gyrocompass, rather than a bench mark or stellar reference as is possible for a fixed emplacement. It is necessary that the rail heading at each launch station be pre-surveyed with sufficient accuracy to permit an initial "rough-North" gyrocompass orientation. Azimuth is transferred from the gyrocompass to the missile guidance package by means of electro-optical equipment on the gyrocompass, and equipment on an elevated leveled platform located near a window in the guidance package.

• **Subsystems in blisters**—The gyrocompass, a twist autocollimator, autocollimator platform, and associated electronics and cabling make up subsystems of the MAS. They are located in blisters on the missile's strongback. The lower blister also provides space for the gyrocompass operator. The optical path for upper and lower portions of the optical system is also enclosed by the strongback, furnishing the missile and the MAS with the same ambient environment.

The three subsystems are controlled by an operator at the gyrocompass control panel. The panel contains four go/no-go lamps to indicate system status. The panel also has a power-on lamp, gyro-cage switch, a switch to slew the gyro to rough-North and a target-angle-set switch. The latter enables the operator to indicate to the command car whether or not target angle has been set into the missile guidance system.

The gyrocompass is a single-axis, pendulous, north-seeking gyro. Within its casing are servos, servo electronics, a gyro motor power supply, synchro transmitter and optical scales. External features include a control panel, scale-reading microscopes, and a load-supporting rotary table which can be oriented to target azimuth.

• **Gyro in action**—To operate the gyrocompass, the gyro is brought up to speed and its spin axis oriented within 5 deg of arc of geographic North. The gyro is then caged. Spin-axis displacement from North causes the earth rotation coupled to the gyro to bring the spin axis toward North. Because this motion is negligibly damped, the spin axis passes through North to return and oscillate about the North direction with a period of eight minutes. Gyrocompass-indicated North is taken as the azimuth midway between easterly and westerly peak positions achieved by the gyro spin axis.

Maximum decoupling of the gyro from accelerations transmitted through its mounting is provided by locating the unit within a float suspended by a thin fiber from the top of an enclosing tank which can be motor-driven about a vertical axis in line with the fiber.

The tank's silicone fluid provides sufficient bouyancy to remove a major portion of gyro weight from the suspension fiber. Lateral bouyancy pro-

Three-assembly autocollimator . . .

vided by the fluid minimizes the effects of horizontal accelerations on the gyro as a result of vibrational environment. Undesired oscillations and other disturbances of the gyro are also damped by the fluid. To minimize environmental disturbances further, the tank's bearing housing is servo-stabilized with the aid of leveling gyros.

Between the gyro float and the tank a pickoff signal is developed which displays gyro azimuth oscillations relative to the tank. To null this signal, the suspension-fiber-support tank is servo-driven about the vertical axis—the followup servo tracks the direction of gyro spin axis. Damping of the gyro desired-azimuth oscillation is minimized through followup of the suspension fiber to eliminate torsional reaction on the gyro and through tank followup of the float.

The lower of two optical scales is mounted to the top of the fluid tank. In effect, this enables an operator, viewing the scale through a microscope, to read out peak displacements of the gyro spin-axis to determine North direction. A table, free to rotate about the vertical axis, is on top of the gyrocompass and supports the lower unit, or "transmitter," of the twist autocollimator. The rotary table and its load are maintained in a level attitude because the table is supported upon the level-stabilized bearing housing of the gyro followup assembly.

An upper microscope eyepiece and an upper optical scale rotating with the optical table permit the operator to set into the table a North reference derived from the lower optical scale. In addition to this North reference, a target angle from North is inserted, thus orienting the twist autocollimator transmitter to the target heading.

A porro prism, located on the rotary table, references table rotation and permits a theodolite operator to compare the gyrocompass-indicated North direction with a surveyed bench mark North reference as during calibration and checkout.

During storage or transport, or when setting in rough-North, the gyro float is kept in a caged condition, so that motion relative to the fluid tank is prevented and the suspension fiber is relaxed. During orientation to rough-North, the fluid tank followup servomotor is run until the gyro spin-axis orientation is appropriate, as read out from the lower scale. The gyro is uncaged only to allow azimuth oscillation of the spin axis or when readings are intended to be taken.

The gyrocompass also has a built-in, crystal-controlled, 400 cps power supply for precision gyro rotor speed control. To provide coarse pitch leveling information for the autocollimator platform, a synchro transmitter is incorporated on the gyrocompass leveling servo.

• **Autocollimator** — Three separate assemblies make up the twist autocollimator subsystem: a lower unit mounted on the gyrocompass rotary table; an upper unit mounted on the autocollimator platform; and a combined power supply and junction box assembly located near the gyrocompass. The latter unit is common to signal and power circuits for all MAS subsystems.

The lower unit assembly consists of the optical synchro transmitter which directs a beam of light to the upper unit assembly. Rotational or "twist" information, consisting of target azimuth, is conveyed upward on this beam. A porro prism on the lower unit facilitates azimuth alinement to the gyrocompass optical table which also bears a porro prism.

The upper unit assembly, positioned approximately 45 ft. above the transmitter, contains the optical synchro receiver which extracts twist information from the vertically projected beam. Also packaged in the upper unit is a dual-axis autocollimator which projects a horizontal light beam through a window in the missile to a mirror in the missile guidance system. The azimuth direction of this beam represents the target azimuth set into the gyrocompass rotary table. The upper unit's optical package also contains electronics for twist autocollimator and a porro prism for azimuth monitoring of system performance.

• **Correction by beam**—The determination of any misalinement between the optical synchro transmitter and receiver is accomplished with a complexly modulated light beam.

Light from an incandescent source is circularly polarized, collimated, and then operated upon by a solid-state electro-optic light modulator. Under application of a high-voltage alternating field, the modulator changes the circulary polarized light into two superimposed, intensity-modulated, plane-polarized beams with polarization planes at right angles.

The composite beam then passes through a quartz correction crystal and is projected upwardly in a diverging path toward the optical synchro receiver. This beam represents the twist orientation of the transmitter, and thus contains target heading information. The correction crystal serves to compensate for the effect of some cross-coupling factors on azimuth accuracy as the optical synchro receiver samples random portions of the upwardly projected beam due to some sway of the missile strongback.

At the optical synchro receiver, the modulated light beam from the transmitter is sent through a quartz plate into a modified Wollaston prism. The prism is so mounted that, like the plate, its sensitive axes are at 45 deg (arc) to the polarization axes, defined by the transmitter. This prism also physically separates light having polarizations 90 deg (arc) apart and directs light of one polarization to one solid-state photodetector and light of another polarization to a second photodetector.

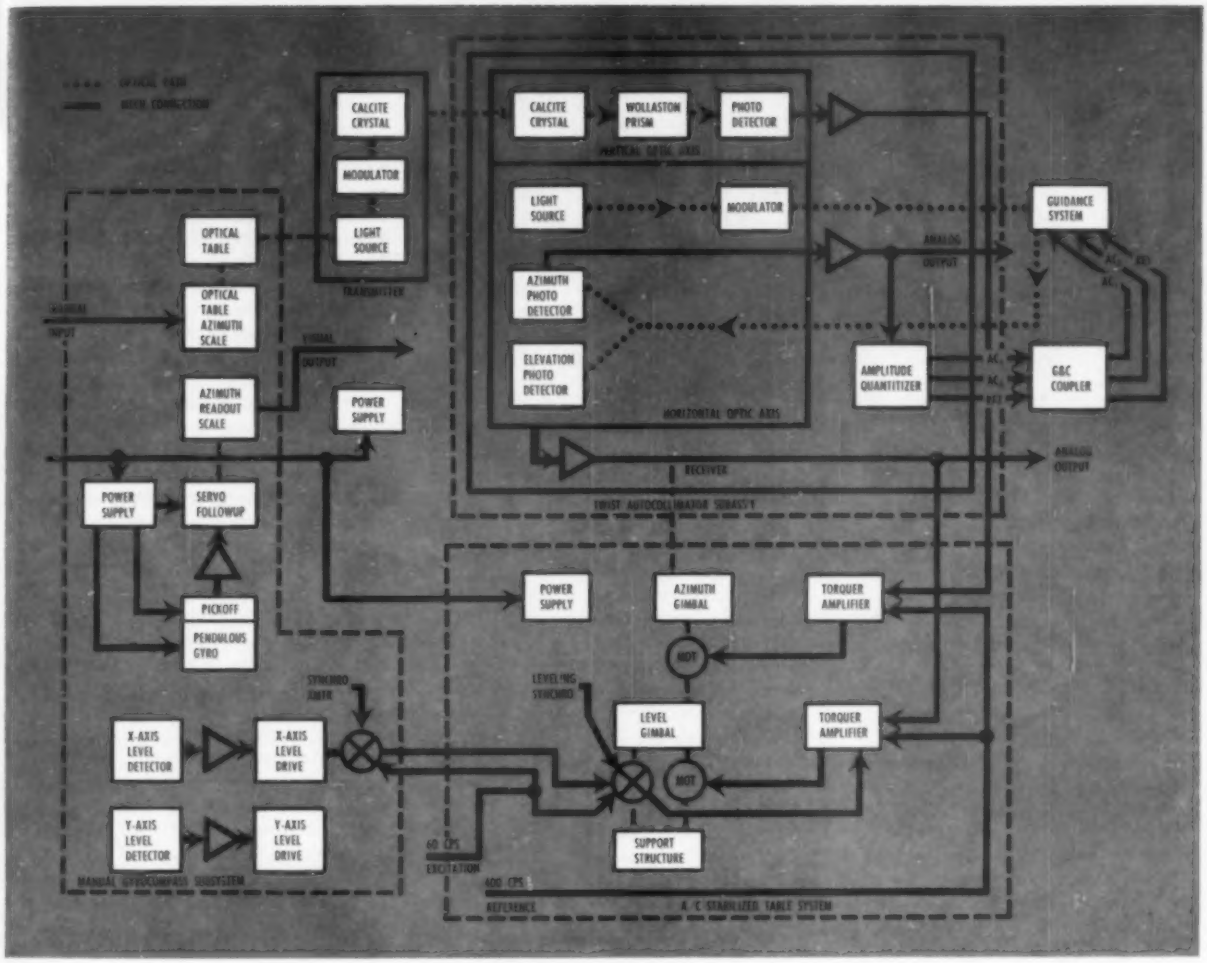
When the receiver is rotationally alined to the transmitter, orthogonal components of each polarization component of the intercepted beam are combined at each photodetector to provide constant light intensity and a DC signal not sensed by the phase detector. However, when twist misalinement exists between the receiver and transmitter, the two photocells observe modulated light beams of opposing phase.

• **Twist signal input**—After separate amplification, detector AC signals are joined at a phase demodulator where the output error signal is proportional in magnitude to the amount of twist between upper and lower optical synchro units. This twist error signal serves as the input signal to the autocollimator platform azimuth axis servo.

In the dual-axis autocollimator, a circular aperture image is projected, and its reflected position is sensed by azimuth and elevation sensing solid-state photodetectors. Light from an incandescent source is modulated in much the same manner as in the optical synchro transmitter, and is projected to the guidance system stable element mirror.

When the mirror is alined, return light falls upon an analyzer reticle so that a photodetector behind the analyzer receives constant light and provides a DC signal which cannot pass the phase demodulator transformer.

The analyzer is composed of two semi-circular polaroid filters, adjoined base-to-base to form a circular element with a straight-line division between polarization vectors 90 deg. (arc) apart. When monitored mirror misalinement exists, the image displacement at the analyzer causes the detector to see more light of one polarization and phase than of the other polarization and phase. By this means, an AC signal is developed which results in a phase demodulator output having a polarity representing the direction of mirror misalinement, and having a magnitude



Functional Schematic for Missile Alinement Set

representing the amount of misalinement.

An analog output signal from the dual-axis autocollimator elevation is sent to the autocollimator platform leveling servo. This provides the autocollimator with the pitch-level attitude of the missile guidance system stabilized platform which is within ±10 sec. arc.

• **Signal conversion**—The azimuth analog signal is converted within the autocollimator electronics to a three-state output on two lines. A given line will either have a signal (the 1-state), or no signal (the 0-state). A (0, 0) output on the line pair represents azimuth alinement of the missile mirror to the autocollimator within ±5 sec. arc. A (1, 0) or (0, 1) state indicates clockwise or counterclockwise error in excess of 5 sec. arc. The three-state output of the twist autocollimator is sent to the Guidance and Control Coupler which causes the G&C computer to torque the missile platform to target azimuth within 60 sec. arc (standard deviation, ±5 sec. arc).

The autocollimator platform consists of a two-axis stabilized mount to position the upper unit of the twist autocollimator in azimuth and level. The platform is enclosed in a housing supported on the missile strongback adjacent to the missile alinement window.

On the inward side of the mounting bracket (for the platform housing) to the missile strongback in a vertical outer gimbal, pivoted within and from the housing about a pitch axis with a ±3 deg. arc of freedom, and an inner gimbal, pivoted about an azimuth axis within the outer gimbal, with ±5 deg. arc of freedom. An in-line direct drive torquer motor is employed on each gimbal axis. In addition, a synchro receiver is provided on the pitch axis. The latter axis lies in a direction at right angles to a line-of-sight into the missile alinement window. Mounted within the inner gimbal is the twist autocollimator upper unit. Electrical connections to the autocollimator and gimbal torquers are achieved by flexure wires across the gimbal axis.

Three optical windows are provided in the platform housing: one for the horizontally viewing dual-axis autocollimator section of the upper unit; one for the optical synchro section; and a third to permit viewing of the upper unit porro prism at an upward angle of approximately 45 deg. arc.

Inputs to both gimbal torquers are supplied from the upper unit electronics package which is mounted on the missile strongback and contains the platform servo electronics. The pitch torquer signal is derived from the dual-axis autocollimator elevation axis output, but this output is available only after the platform is rough-leveled by the synchro loop to the gyrocompass.

The azimuth torquer signal is derived from the optical synchro transmitter output. Leveling of the platform is necessary to eliminate cross-coupling effects which would otherwise degrade azimuth alinement. Leveling of the upper unit porro prism is necessary to prevent azimuth readout error, when monitoring it at a steep angle from the ground during checkout. ⌗

Elaborate plans . . .

Navy, AF Teams Set For Recovery Of Astronaut

Fleet force is responsible for probable landing areas; Air Rescue Service has job of covering rest of world

by Jay Holmes

HISTORY'S MOST FAR-FLUNG operation to save the life of one man will swing into operation with the first of the Project *Mercury* manned orbital flights.

The Air Force's Air Rescue Service is preparing to deploy pararescue men with special underwater training in five of the seven seas, poised to pluck the capsule and its human passenger from any point in the ocean along the path of the three *Mercury* orbits.

Nine pre-planned impact areas in the North Atlantic have been selected by the National Aeronautics and Space Administration and the Navy's Destroyer Flotilla 4, responsible for covering high-probability landing areas. The Air Rescue Service will be responsible for covering the rest of the world.

The operation planned for manned orbital *Mercury* flights is much more extensive than that in operation last week for the suborbital *Mercury Redstone* ballistic launch. Only two areas, that around the Cape itself and one around the intended landing area, 290 miles downrange, needed to be covered. The entire *Redstone* recovery operation was handled by eight ships and numerous small craft, aircraft and land vehicles of Destroyer Flotilla 4, commanded by Rear Adm. F. V. H. Hilles.

For the *Atlas*-boosted manned orbital shots, expected to begin about a year from now, ARS has set up provisions to reach any point on earth within 18 hours. Navy and Strategic Air Command aircraft will be aloft above all parts of the three orbits during the capsule's programed 4½-hour flight. They will have 1½ hours to move from one area to another as the orbit precesses.

• **Sea spells trouble**—If the capsule comes down on level dry land, rescuers will have little difficulty. Each orbit, however, brings the spacecraft across broad areas of Africa and Australia—where it is likely to land in remote jungle or desert regions. Pararescue forces will be prepared for such eventualities.

But the most complex problems will develop if it plunges into the almost endless stretches of the North Atlantic, South Atlantic, North Pacific, South Pacific and Indian Oceans outside the planned impact areas.

For the sea rescue job, Air Rescue Service will deploy 56 volunteers specially trained in techniques for using Self-Contained Underwater Breathing Apparatus (SCUBA). Half of the 56 will be assigned to Destroyer Flotilla 4 for service in the nine pre-planned land-

IN LESS than five minutes, pararescuemen in drill have jumped from plane, made "nylon let-down," affixed flotation device to capsule, and await pick-up. In actual operation, they would open capsule and aid astronaut.

ing areas. The remainder will cover the seas around the world.

The first *Mercury* rescue volunteers began training last summer at the Navy frogman school at Key West. The first two men in the program, M/Sgts. William R. Hyatt Jr. and Charles Tolbert, are now at Air Rescue Service headquarters at Orlando AFB, Fla., developing techniques for the men who will follow.

Some of the airmen will have the benefit of some particularly pertinent experience helping recover *Discoverer* capsules from the Pacific Ocean. As many as eight pararescue men have been assigned to some of the *Discoverer* operations.

• **Split-second operation**—In general, the rescue men will be deployed on a "buddy" basis, two in each plane. Thus, 28 pararescue aircraft will take part in a *Mercury* orbital operation, 14 in the planned recovery areas and 14 around the world. However, altogether as many as 60 Air Force, Navy and Coast Guard aircraft may take part, the others serving as spotters and in other auxiliary duties.

The SCUBA-trained pararescue man will carry 160 lbs. of equipment, including 20 lbs. of lead weights to allow him to swim under water—for maximum speed in reaching the floating capsule. Here is the planned recovery procedure:

–Drop spotter's chute toward capsule. Count seconds until aircraft is over the capsule, so as to know how long it will take on the next pass.

–Jump.

–Get rid of reserve chute while airborne.

–Deploy rescue raft, which inflates in the air.

–Attach first aid kit to long lanyard.

–Pull pins releasing chute just before reaching water surface.

–Impact within 10 ft. of raft.

–Orient self on capsule.

–Attach lanyard to raft.

–Swim underwater to capsule.

–Plane drops flotation device, a specially modified 20-man raft.

–Inflate flotation device, slip it under capsule and float it.

Meanwhile, the second pararescue man has joined his partner. The rescuers can unbolt the side cover of the capsule after it is on the floating raft, if the astronaut has not already opened either the top or side exit from inside.

The rest of the operation is routine. ⁂

ABOVE: *Air Rescue Service SCUBA team prepares for jump. MSgt Nicolas Klimis double checks rigging worn by TSgt Joe L. Williams. Equipment surrounding the men weighs as much or more than either of them.* **BELOW:** *Klimis holds flotation device firmly in place while Williams starts to hand crank the "purse string" retainer cables tight. When this task is completed, the flotation collar will be inflated and the rescue team will, if necessary, climb aboard to help the astronaut.*

New Formula for Pricing Space Work

AAS meeting told of Chance Vought cost analysis method; 8-year moon round trip plan tagged at $3.1 billion

AN EIGHT-YEAR PROGRAM, culminating in manned lunar landing and return, would carry a price tag of about $3.1 billion.

The figure is the result of applying a cost analysis method developed by Chance Vought Corp. to a sample space program; it represents all expenses except booster development costs and existing facilities.

Details of the analyzing process and the space mission were presented to the American Astronautical Society by T. E. Dolan, W. G. Long and R. H. Lundberg at the seventh annual meeting held in Dallas recently.

By mission phase, the program costs for manned lunar landing and return (MALLAR) through oribtal qualification of the command module are $771 million, while earth oribtal qualification and demonstration of the manned command/mission/assembly is $603 million.

Breaking the total down even further, the actual hardware costs of the specific MALLAR mission, the program objective, is about $21.2 million. Ground tests would cost $145 million while total tests, including flight, would reach $875 million.

Crew training would gobble up $42.7 million but Vought studies in other areas indicate that this could be reduced through sophisticated flight simulation facilities. Flight operations are tagged at $273.6 million, support costs at $91 million and spares costs at $86.3 million.

A generalization of the theoretical lunar mission permits the following conclusions:

–Manned space missions in the next 15 years will include up to 75% of the program costs in non-recurring and/or developmental areas. Thus in the specific example, the second mission would cost only $200 million.

–Space system cost analysis information equals technical feasibility in importance to the potential customer.

–The weakest area of true program cost forecast lies in availability of basic cost data and conversion of apparent costs to actual costs.

Other papers presented at the meeting included:

–The effect of the Martian upper atmosphere and ionosphere on communications was covered by G. Yanow of Douglas Aircraft Co. Yanow reported on preliminary results for density, temperature, mean molecular mass, electron density and other atmospheric characteristics derived from hypothetical Martian models composed of 95% N_2 and 5% CO2. If current values of the Martian environmental conditions and chemical composition are taken, it is plausible to suggest the existence of a fairly dense, multilayered, high altitude ionosphere about Mars.

This further suggests that terrestial communication techniques could be employed but using different frequencies and skip distances.

–The adverse effects of space vehicle rotation on man and inanimate objects was presented by G. T. Beauchamp of Lockheed's Missiles and Space Division. A study of the Coriolis forces acting upon moving bodies within rotating vehicles reveal a definite pattern which dictates certain requirements in vehicle design.

Beauchamp concludes that the optimum vehicle radius at floor level should be from 45 to 50 feet. Smaller radii will result in intolerable Coriolis components and gravity gradients.

For satisfactory human operation at low simulated gravity levels, the vehicle rotational radius would require extensions to several hundred feet.

–Impact on vehicle design by the requirement of producing artificial gravity were discussed by A. M. Mayo, Life Sciences Program, NASA. The need for artificial gravity is generally recognized, based on the absolute demand for optimum efficiency from an astronaut.

• **Spin effect**—Mayo suggests at 1 rpm rotation with a 1 G equivalent acceleration to induce this artificial gravity. This would require a radius of rotation slightly under 3,000 ft. involving a weight penalty on the order of 10% of the initial orbiting weight of a vehicle system.

–The mass shielding requirements for flight during extreme solar flare proton events were covered by T. Foelsche of NASA's Langley Research Center.

During maximum activity, a cylindrical shelter of H_2O equivalent material having an inner diameter of 1 meter would be needed. This means a weight factor of 4000 to 5000 lbs.

The examples for calculation of doses behind different amounts of shielding were chosen from the high energy event on Feb. 23, 1956, the low energy extreme flux events from May 10 to July, 1959 and the high flux event of August 22, 1958.

–The "atmosphere" of the moon was described by S. Fred Singer of the University of Maryland. The atmosphere is the result of the moon's being positively charged by solar ultraviolet photon action. This space charge field is strong enough to affect radio communication at low frequencies.

Besides this, says Singer, the field kicks out small, positively charged dust particles from the lunar surface. These reduce and partly cancel the negative space charge of the electron cloud and allow the cloud to expand to a greater distance of the order of a meter. The electron field is also reduced and the dust particles fall back to the surface but are replaced by others. Singer concludes that the moon has a dust atmosphere of positively charged dust particles and negative electrons. ⠿

Lockheed Building Reactor for NASA

Lockheed's Georgia Division will build a low-power nuclear reactor for the National Aeronautics and Space Administration at its Plum Brook facility near Sandusky, Ohio.

NASA awarded Lockheed a $404,-002 contract to build the reactor by 1962. It will be used to check feasibility of proposed experiments on the 60-megawatt research reactor, which NASA says is to go critical in March.

The Atomic Energy Commission has extended the completion date of the high-power reactor from Jan. 1, 1961, to Jan. 1, 1962. The AEC said NASA reported the delay was necessary because of imperfections in manufacture of the reactor tank, additional piping work and other problems. ⠿

Where to Get 'Birdsmanship'

M/R's review of Strictly Birdsmanship (Jan. 23, p. 44) neglected to mention the address of the Benson-Lehner Corp., the only place where copies can be ordered. In answer to numerous inquiries, the address is:

1860 Franklin Street,
Santa Monica, Calif.

Kennedy—Defense

(Continued from Page 16)

uncertain risk and great commitment," he said. "Each day we draw nearer the hour of maximum danger as weapons spread and hostile forces grow stronger."

This was as close as he came to saying that the Missile Gap is generally expected to be at its greatest in 1962 and 1963.

Kennedy's immediate steps to meet this danger were to call for a speed up in construction of *Polaris* submarines, procurement of more military cargo and transport aircraft and acceleration of "our entire missile program."

He said the last item would be confined mostly to "improving organization and decision making" while he awaited McNamara's reports. The first two items involved hardware.

The call for more airlift—possibly more than 200 planes—was widely interpreted in the Army and elsewhere to mean that much greater emphasis would be put in the future on modernizing the Army's semi-starved combat divisions.

This could mean sizeable increases in the procurement of such tactical missiles as nuclear-tipped *Davy Crocketts, Sergeants* and *Pershings*. It also might mean approval of the Army proposal to extend *Pershing's* range to 1000 miles.

• **Saving nine months**—The increase for *Polaris* doubled from 5 to 10 the number of *Polaris* sub keels that have been approved by the Administration for FY '61. They will be paid for partly with funds borrowed from the *Polaris* sub account. No new money is required now.

The final Eisenhower budget submitted to Congress last month repeated the order for FY '62: Five more *Polaris* subs and lead time items for another five.

Kennedy now has proposed to take the five subs out of the FY '62 budget and put them in the budget for FY '61. In effect, he is doubling the FY '61 order and leaving the FY '62 order to be filled in later.

The Kennedy order means that nine months can be saved in building the five additional subs. It also means that the Navy will begin launching a *Polaris* submarine a month in October 1963. This can go on as long as the nation continues to build 12 a year.

In all, 24 *Polaris* submarines have now been authorized or are under construction. The Navy also is preparing to arm the nuclear-powered cruiser Long Beach with eight *Polaris* missiles.

The Long Beach is scheduled to be commissioned early this fall. Then, after a three-month shakedown cruise, it will undergo 20 months of yard-work including the installation of tactical radars, fire control equipment and *Polaris* launching tubes.

So far, the Long Beach is the only cruiser that the Navy has been authorized to arm with *Polaris*. However, proposals to arm others are certain to be pressed.

Navy officers were delighted that *Polaris* was the only one of the Big Four strategic missile systems that Kennedy mentioned by name in his State of the Union Address. Many felt that Navy proposals to build a fleet of 45 *Polaris* submarine seldom looked more assured.

However, all three services took at least some comfort in Kennedy's statement that his Administration would give equal attention to the olive branch and the arrows grasped in the talons of the American eagle on the Presidential Coat of Arms.

It also was noted that at this point both the Democrats and the Republicans applauded. ⌗

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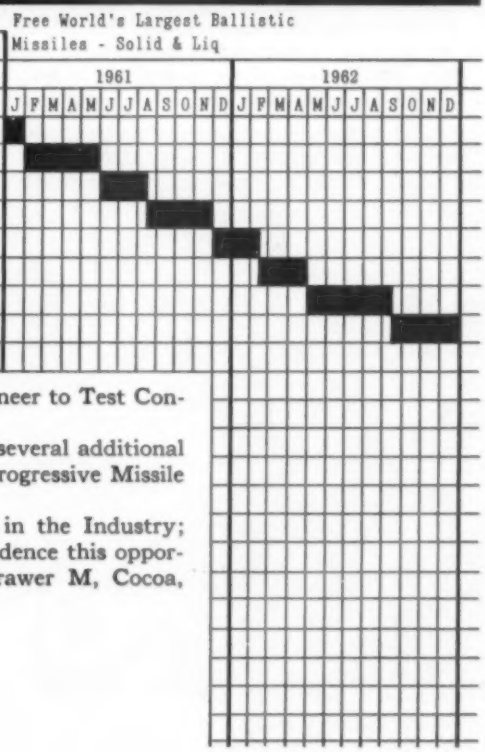
2	" " " " " Prop.	15%
3	" " " " " El.	10%
4	" " " " " F/C	15%
5	" " " " " M/S	10%
6	" " " " " Inst.	10%
7	Asst. Test Conductor	20%
8	Test Conductor	15%
9		



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MARTIN

France to be Major Missile Power

De Gaulle plans on spending at least $2.4 billion in next four years on new special weapons

by Bernard Poirier

UNDER PRESIDENT DE GAULLE'S hard-won new "Program Law" France may achieve a nuclear air/missile strike capability within four years.

The law commits a minimum of $2.4 billion through 1964 for a wide spectrum of new weapons designed to give France the ability to protect her far-flung territory—roughly four million square miles spread around the globe.

Equally important, de Gaulle's ambitious plans would make France a major military power in the missile age.

An analysis of the program indicates that within a year the French defense industry will be moving at high gear—including several U.S. firms with affiliations in France.

Until the Program Law went into effect France would have spent $1.26 billion a year for weapons procurement and development. The money would have been committed on a year-to-year basis, adding up to $6.3 billion over five years.

What de Gaulle has done is to commit 25% of this $6.3 billion in the first year on special weapons.

• **Spending breakdown**—Funds are allocated under the new law by mission rather than strictly by military service. The breakdown:

–Air Force materials—$546 million

–Other aeronautical materials—$281 million

–Ships construction and FBM R&D—$189 million

–Army materials and modernization—$356 million

–IRBM and nuclear development—$986 million.

The Navy portion contains $165 million for a prototype nuclear ballistic submarine, three missile escort cruisers and two Daphané class submarines. It includes $24 million "for the research of a *Polaris*-type missile for the nuclear submarine." The cruisers will also carry new missiles such as the improved *Masurca* antiaircraft batteries.

Fifty Dassault Etendard IVM fighters will be deployed on carriers, particularly the newer Foch and Clemenceau. The Navy also gets 27 Breguet NATO Atlantic patrol aircraft. This buy is financed from $142 million.

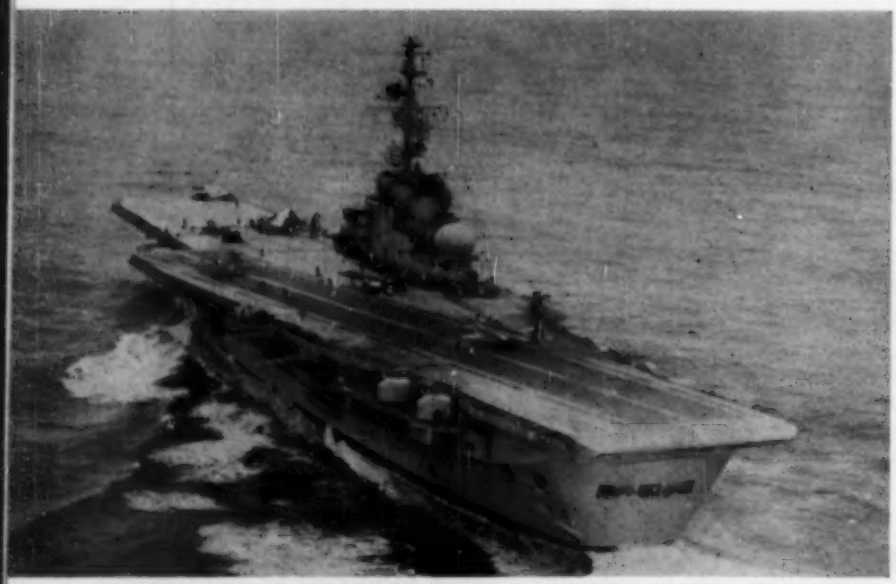
A lesser amount for 220 helicopters—some carrying missiles—is shared with the Army. Included are 150 light Alouette types and 70 Frélon types, both manufactured by Sud Aviation. Most of the missile armament on naval aircraft will be provided by Nord and MATRA.

The French Air Force maintains an airborne missile of strike force in the Mirage IV mach 2.2 fighter/bomber. Fifty of these and 226 Mirage III fighters will be procured from a $546 million materials appropriation.

• **Missile armed**—G.A.M. Dassault, maker of both Mirage models, recently set a world's record with the 'IV'. This 1100-1400 mile range aircraft will carry advanced *MATRA* missiles and stand-off nuclear tipped missiles to be developed from $212 million in the missile pot. It will be able to reach most targets in Eastern Russia and return to French bases.

A company spokesman at Saint-Cloud says, "The aircraft will be able to carry French nuclear bombs delivered with air-to-ground missiles. It will carry counter-measure devices against enemy radar plus air-to-air missiles."

Presumably, the counter-devices are Carcinotron-M electronic hyperfrequency units developed by Dr. Robert R. Warnecke's technical group at C.S.F.'s Centre de Physique Electronique et Corpusculaire located at Corbeville par Orsay.



FRENCH CARRIER CLEMENCEAU and the Foch (same class) will be provided with new, missile-armed Etendard strike fighters, one of which is shown on center deck.

FRENCH ARMY has one battalion of mobile surface-to-surface Sud Aviation

The Air Force will manage a $77 million allotment for continued research on NATO patrol aircraft. This, plus another $56 million, gives this service the largest share—$680 million dollars.

The Army will get new weapons, Algerian troops will be modernized and the same procedure will follow next among French forces in West Germany.

The Army already has one battalion equipped with *Sud 4200* tactical missiles. Undoubtedly, this capacity will be augmented and development of a new *Parca* antiaircraft missile will be accelerated.

DEFA's Research Laboratory at Vernon has already undertaken design and engineering effort for a mach 3 version. It will be deployed against high altitude supersonic aircraft.

Land and sea based IRBM's will be developed concurrently. S.E.R.E.B. is the organization responsible for the R&D effort. Its overall effort will be supported by industrial leaders like Sud, Nord, Latecoère and MATRA. Sud is prime within S.E.R.E.B. for IRBM development and has been supported by O.N.E.R.A. and SEPR. Tests have already been conducted from the Navy's Mediterranean site on Levant Island.

Considerable benefit will be derived from their experience with anti-tank missiles, ASW missiles and air launched missile systems. Moreover, MATRA has developed the solid two-stage *R 422* which has been tested on *Véronique* complexes at Hammaguir.

In a New Year's Eve report to the people de Gaulle said, "We are continuing the vast scientific, technical, educational and economic development in which we have been engaged and which leads to prosperity, influence and strength, and which throws open careers to more (within our) young generation."

The real big push will be in the area of deliverable nuclear packages. At least $762 million is available.

Cost of the first French A-Bomb is estimated at $400 million. Further, the nuclear isotope separation plant at Pierrelatte will cost about $300 million.

Other French studies reveal research costs for a *Thor*-type missile would be seven times cheaper in France, and fabrication, three times cheaper. They claim only $24 million has been expended to date on missile research and with comparable success. This figure appears low.

To support IRBM development, the Law includes $45 million for solid propellants and an equal amount to augment existing test facilities. Total cost up to the production model is projected at $800 million.

No amounts are given for other essential portions of an IRBM weapons system.

On the other side of the ledger, a high ranking French Comptroller estimated that the costs of recapturing enriched uranium for shipboard reactors "would be much higher in France than in the U.S.A.; at least as is foreseeable during the next ten years."

One argument during the debate on the Law revolved around the offer of a nuclear deterrent by the U.S. to NATO in the waning days of the Eisenhower administration. However, analysis points out little which could conflict between this offer and the Program Law. There are apparent advantages to both.

The only disadvantage is intrinsically woven into NATO's geopolitical fabric. NATO is only as strong as the adhesion joining fifteen members and not in the concept of a weakest member. The Cold War has often emphasized the struggle of Western resources versus those of the Soviet camp. Yet NATO, particularly the three largest members, has persisted in redundant investment for research in areas of proven weapons systems.

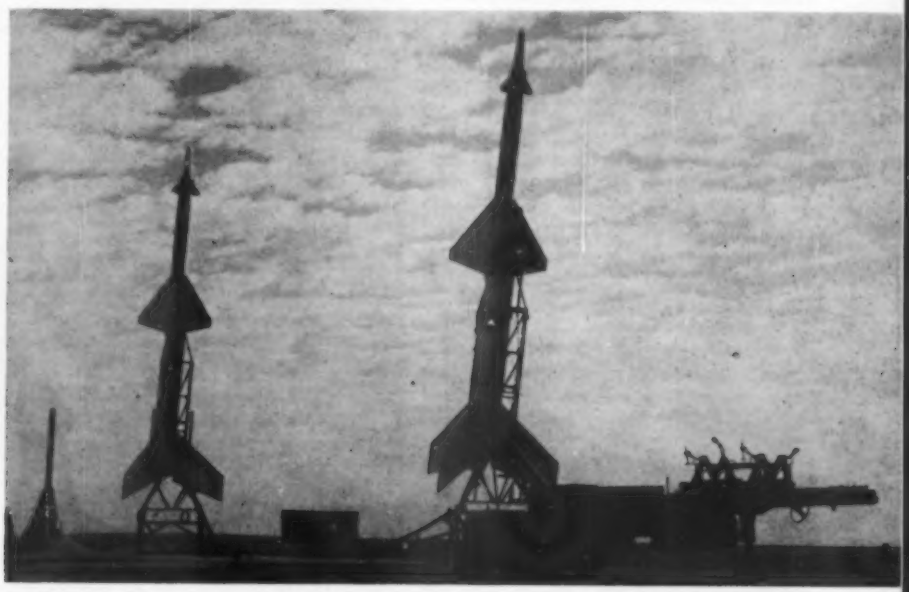
Many delegates to the recent NATO Parliamentarian Conference recognized NATO's "growing pains" in this area and some legislators hinted at corrective measures for the Alliance. ⌗

French PROGRAM LAW for Defense

(in millions of dollars)

	TOTALS	Army	Navy	Air Force	Common R&D Effort		
					Missiles	Aircraft	Nuclear
Air Force Materials	$ 546	..	..	$546	..	..	..
Non-AF Air Materials	$ 281	..	$142	$133	..	$ 6	..
New Ships Construction and FBM Development	$ 225	..	$165	..	$ 24	..	$ 36
Army Materials	$ 356	$300	..	..	..	$ 56	..
Strike Force RDT & E	$ 950	..	..	..	$188	..	$762
TOTALS	$2,358	$300	$307	$679	$212	$ 62	$798

SE 4200 missiles. The radio-guided "Flying bomb" has range up to 55 miles.



MATRA R 422 two-stage solid missiles are among the largest developed by France and have been successfully tested. Company will have major role in new program.

Early job for Webb . . .

How Much More Should NASA Ask?

Eisenhower budget set new high in space agency funding but was thrice-trimmed below Glennan's request

AMENDMENTS TO former President Eisenhower's budget will be among the first items of business for James E. Webb, new chief of the National Aeronautics and Space Administration. The Kennedy Administration requested NASA's views on the budget even before his appointment.

Eisenhower and his budgeteers cut more than $250 million from the new money sought for fiscal 1962 by former Administrator T. Keith Glennan. The NASA budget went up to the White House and returned at least three times, with deeper cuts each time.

The new NASA Administrator, will have to decide whether to seek the entire amount, something less or, perhaps, more than Glennan wanted. A request for additional money seems certain to be greeted favorably, at least by Rep. Overton Brooks (D-La.), chairman of the House Space Committee. Brooks has said NASA ought to spend at least $1½ billion in the coming year.

The Eisenhower budget calls for $1,119,630,000 in new obligational authority for 1962 and a supplemental appropriation of $49.6 million for 1961. The 1962 request is 22% higher than the final 1961 total voted last year. It includes new money for research and development totaling $819.-million, compared with $621.453 million voted finally last year.

• **Cutbacks**—Several major R&D programs, which NASA has announced would begin in the next fiscal year, were eliminated or cut sharply. The most important were:

–Project *Apollo*, the three-man spacecraft, given $29.5 million for in-house studies and research on radiation shielding problems. Eisenhower rejected a NASA proposal to begin hardware R&D.

–Project *Rover*, the nuclear rocket engine development program, given $2.6 million in the supplemental and about $14 million in '62. The supplemental will allow NASA to choose a prime contractor this spring and put the contractor to work in support of engine work at the Los Alamos Scientific Laboratory of the Atomic Energy Commission. However, neither the supplemental nor the '62 budget contains funding to pay for development of nuclear rocket-engine hardware.

The budget cuts are reflected in Glennan's stretchout of the first flight test of the *Rover* engine from 1965 to the 1966-67 period. In fact, an official close to the program said, the level of funding does not even provide for meeting the stretched-out schedule.

–*Saturn* S-II stage, an 800,000-lb.-thrust cluster of four Rocketdyne J-2 liquid hydrogen engines, which will be the second stage of the second-generation *Saturn*, designated *C-2*. NASA had announced plans to hold a bidders' conference in May or June 1961 and award a contract to begin R&D on the stage early in 1962.

The S-II stage status in 1962 is similar to that of Project *Rover* in 1961. A relatively small, but unspecified, amount is provided to begin work with a contractor late in the fiscal year.

• **Mercury still top priority**—Project *Mercury* comes in for $74.245 million, a decrease of $35 million from '61. This does not represent a cutback, however, since it was anticipated from the start that *Mercury* would reach its spending peak in FY '61. NASA budget briefers said *Mercury* is still "fully funded" and assumes continuation of the DX priority—the nation's highest.

Mercury and *Apollo* together total $103.745 million, a decline of $7 million for manned space flight from 1961. Budget briefers denied, however, that the total is not an indication of the total effort for manned space flight. They said work on the *Saturn* booster and life science research also should be considered and those two items are rising.

The total cost of developing *Saturn*, carried in several NASA accounts, will be about a quarter-billion in '62, which budget briefers voiced hope will be the peak year.

• **Stress on communications**—Communication satellites were the biggest item in the $49 million supplemental '61 request. NASA wants to spend $24 million this year, mostly to begin an industry development program on the Project *Relay* active repeater satellite. Some of the money will go toward developing a bigger—140-ft.-diameter—*Echo* balloon satellite of somewhat stiffer material. Two additional *Delta* vehicles and two additional *Atlas-Agena* vehicles are to be procured for boosting communications satellites.

The '62 budget is to include $44.6 million for communications satellites, compared with $3.912 in '61, almost all of which went for Project *Echo*. The budget assumes receipt of $10 million from private industry as a fee for procuring and launching rockets to test a privately owned active communications satellite.

Other items in the supplemental are:

–$16.18 million to procure additional *Centaur* vehicles.

–$5 million for long lead-time costs, mainly down payment on a booster, for the Project *Mariner* interplanetary spacecraft to be flown next year.

–$1.825 million for uprating the third and fourth stages of *Scout*, the so-called *"Super Scout."*

–$2.6 million for Project *Rover*.

The budget provides $476,000 in staff salaries and $8.62 million in research grant money to be let by a new life sciences laboratory to be established at NASA's Ames Research Center at Moffett Field, Calif. The budget provides $6.38 million in construction at Ames, much of which is for the life sciences center.

The center came into existence Feb. 1, and will gradually grow to a staff of about 60 scientific people and 140 supporting technicians, NASA said.

• **Other cuts**—Deleted from the budget, apparently by Eisenhower, was a proposal by Jet Propulsion Laboratory to build the first of three 250-ft. antennas for its Deep Space Instrumentation Facility.

These other items, sought by groups within NASA, were deleted either before the budget left the space agency or afterward:

–Project *Aeros*—Study or R&D of a 24-hour stationary weather satellite equipped with Zoomar TV lenses for closeups of hurricanes and other major storms.

–R&D on a large solid-propellant launch vehicle as a backup for *Saturn*.

–A third *Saturn* launch complex at Cape Canaveral, to provide capability of multiple launchings in support of rendezvous operations.

–Parallel development of a *Rover* nuclear vehicle stage, in addition to engine development. ⌗

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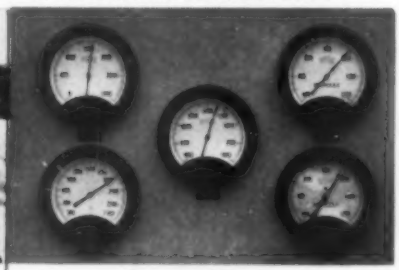

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8 Reasons Why So Many Firms Insist on Kin Tel TV Systems

1. Reliability. KIN TEL equipment is designed to keep working, day in and day out. It's the first choice for ICBM and other missile programs that depend on TV, that can't afford to compromise with reliability.

2. Picture Quality. Full 650-line resolution provides maximum delineation, essential for qualitative observation of complex operations, and for transmission of printed material.

3. Automatic Operation. KIN TEL TV is the only closed circuit system that provides entirely automatic, through-the-lens compensation for light-level changes of several thousand to one.

4. Sensitivity. With KIN TEL equipment, the light needed to read this page is enough for sharp, clear pictures; and usable pictures can be provided with less than one foot-candle illumination.

5. Ease of Installation. No site preparation is needed, no interacting electrical adjustments are required. All units fit in standard 19-inch racks.

6. Simplicity of Operation. With no changes in lens iris to make, the only thing the operator has to know is the location of the on-off switch.

7. Adaptability. A complete line of shelf-item system components and a variety of cameras and monitors permit observations of nearly every kind of operation, under all kinds of conditions.

8. Application Help. You don't have to waste your money and time on application engineering. At no obligation, KIN TEL's nationwide factory-trained field engineers will determine whether or not a TV system can be put to profitable use in your intended application.

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC.

5725 Kearny Villa Road, P.O. Box 623, San Diego 12, California, BRowning 7-6700

KIN TEL—pioneer and leader in closed circuit television

Circle No. 4 on Subscriber Service Card.

contracts

NASA

$3,000,000—Packard Bell Electronics Corp., Los Angeles, for an automatic checkout system for the *Saturn* space vehicle booster.

NAVY

$1,012,559—Del Mar Engineering Laboratories, for expendable high-performance tow targets.

$500,000—Atlantic Research Corp., Alexandria, Va., for an auxiliary rocket of advanced design for the *Polaris* system. Subcontract from **Lockheed's Missile Systems Division.**

$350,000—Perkin Electronics Corp., El Segundo, Calif., for power supplies to be used in shore support and on-board submarine launching of the *Polaris* missile.

$286,000—Bulova Watch Co.'s Electronics Div., Woodside, N.Y., for frequency control devices for the command guidance system of the *Bullpup* missile. Subcontract from **The Martin Co.**

AIR FORCE

Bell Aerosystems Co., Buffalo, N.Y., for studying the feasibility of building a visual space flight simulator to prepare astronauts for what they will see when they actually get out into space. Amount not disclosed.

$2,125,861—Pacific Semiconductors, for delivery of ultra-high-reliability silicon computer diodes to be used in *Minuteman* production. Subcontract from **Autonetics Div., North American Aviation, Inc.**

$2,000,000—Baird-Atomic, Inc., Cambridge, Mass., for a reliability testing program in connection with the *Midas* satellite program. Subcontract from **Lockheed's Missiles and Space Division.**

$600,000—The Electronics Div. of Chance Vought, Dallas, for electronic test equipment for the *Titan* missile. Subcontract from **AC Spark Plug Div. of General Motors Corp.**

$512,000—The Martin Co., Baltimore, for *TGAM-83* guided aircraft missiles and related support items.

$400,000—Perkin Electronics Co., El Segundo, Calif., for special power supplies for *Titan* missile ground support equipment.

$200,530—Boeing Airplane Co., Aero-Space Div., Seattle, for technical data applicable to the *IM99A* and *IM99B* missiles. Five contracts.

ARMY

$11,500,000—Sperry Gyroscope Co., a division of Sperry Rand Corp., Great Neck, N.Y., for the development and construction of high power transmitters for the discrimination radar system of the *Nike-Zeus* missile system. Subcontract from **Bell Telephone Laboratories.**

$6,000,000—Convair, Div. of General Dynamics Corp., Pomona, for initial development of the *Mauler* guided missile system.

$3,000,000—Columbia University, New York City, for analysis of radar noise in the *Nike* and related systems.

$2,972,288—Radioplane Div., Northrop Corp., Van Nuys, Calif., for target missiles.

$2,545,262—Collins Radio Co., Cedar Rapids, for construction of facilities for *Minuteman* missiles at Vandenberg AFB.

$1,437,106—Sperry Rand Corp., Salt Lake City, for repair parts for the *Sergeant* missile system. Four contracts.

$368,000—International Builders of Florida, Inc., Coral Gables, for construction of an addition to a missile assembly building at Cape Canaveral.

$339,992—Sperry Rand Corp., Salt Lake City, for *Sergeant* missile ground handling equipment. Two contracts.

MISCELLANEOUS

$830,000—Sanders Associates, Inc., Nashua, N.H., for subminiature rate gyros. Subcontract from **North American Aviation's Autonetics and Convair.**

Super Power Hydrogen Thyratron Test Set

Dynamic solutions with creative ingenuity

FXR's high power electronics has produced the Super-Power Hydrogen Thyratron Test Set used as the tool for the development of super-power modulator tubes.

FXR's top-rated position in High Power Electronics can be credited to extensive, specialized facilities. But most important in serving you are the creative abilities of FXR's engineering staff.

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FXR, Inc.

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when and where

FEBRUARY

Second Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (unclassified), South Texas Section of SNT and Southwest Research Institute, Gunter Hotel, San Antonio, Feb. 14-16.

Institute of Radio Engineers, International Solid-State Circuits Conference, 8th Annual Meeting, Sheraton Hotel and University of Pennsylvania, Philadelphia, Feb. 15-17.

American Society for Metals, Albuquerque and Los Alamos Chapters, Recent Developments in Materials for Nuclear Applications, University of New Mexico, Albuquerque, Feb. 16-17.

American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting, St. Louis, Feb. 19-23.

Pacific Electronic Trade Show, Great Western Exhibit Center, Los Angeles, Feb. 26-Mar. 1.

American Institute of Chemical Engineers, National Meeting, Roosevelt Hotel, New Orleans, La., Feb. 26-Mar. 1.

Armed Forces Management Assoc., Annual National Conference, Shoreham Hotel, Washington, D.C., Feb. 28-Mar. 2.

Association of Iron and Steel Engineers, Los Angeles, Feb. 28-Mar. 2.

MARCH

Optical Society of America, Roosevelt Hotel, Pittsburgh, Mar. 2-4.

Gas Turbine Conference and Exhibit, sponsored by Gas Turbine Power Division of American Society of Mechanical Engineers and U.S. Department of Defense, Shoreham Hotel, Washington, D.C., Mar. 5-9.

Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, co-sponsored by IRE (PGNS), AIEE, IAS, University Museum, Philadelphia, Mar. 9-10.

Institute of the Aeronautical Sciences, Flight Propulsion Meeting, (classified), Cleveland, Mar. 9-10.

American Rocket Society, Test Operations and Support Conference, Biltmore Hotel, Los Angeles, Mar. 13-16.

American Society of Mechanical Engineers, Aviation Conference, Statler Hotel, Buffalo, N.Y., Mar. 13-17.

1961 Missile/Space Conference and Goddard Memorial Dinner of the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16.

Fifth National Conference on Aviation/Space Education, Mayflower Hotel, Washington, D.C., Mar. 16-18.

American Congress on Surveying and Mapping and American Society of Photogrammetry, Convention, Shoreham Hotel, Washington, D.C., Mar. 19-25.

IRE International Convention, Coliseum and Waldorf-Astoria Hotel, New York City, Mar. 20-23.

names in the news

TALLENT

MAGINNIS

JACKSON

MILLER

KINZEL

William P. Maginnis: Former vice president of IT&T Component Division and president of Kuthe Laboratories, joins Maxson Electronics Corp. as vice president, research and development. Prior to joining IT&T in 1951 he served for 21 years with the Radio Corp. of America.

Frank G. Chambers: Elected chairman of the Board of Directors at Hazleton-Nuclear Science Corp., succeeding **Eugene M. Zuckert,** now Secretary of the Air Force. Chambers continues as president of the Continental Capital Corp. and of Maydwell & Hartzell, Inc.

Edward H. Heineman: Elected to the board of directors of Summers Gyroscope Co. Prior to joining the firm as executive vice president last year, he served as corporate vice president of the Douglas Aircraft Co.

Dr. Burton F. Miller: Vice president and director of advanced technical planning for Thompson Ramo Wooldridge Inc. has received a three-year extension of his appointment to the Scientific Advisory Board of the United States Air Force.

Dr. Augustus Braun Kinzel: Vice president-research of Union Carbide Corp., elected to the board of trustees for The American Optical Co. He is also a member of the Defense Science Board, Office of the Secretary of Defense; member of the Naval Research Advisory Committee; member of MIT Corp.; chief consultant in metallurgy to Los Alamos Laboratories, Argonne Laboratories and Oak Ridge National Laboratory.

Dr. George F. Huff and **J. S. Bardin:** Elected vice presidents of Callery Chemical Co. Dr. Huff heads the company's research and development and Mr. Bardin is in charge of manufacturing.

C. M. Aker: Named vice president-engineering for International Telephone & Telegraph Corp.'s Industrial Products Division.

James B. Williams: Vice president of Electronic Communications Inc., and general manager of its St. Petersburg Division, elected a director. Prior to joining the firm in 1960, he was for 17 years with Philco Corp. as director of weapons systems engineering and chief engineer for communications.

Col. Charles G. Patterson: Former director of special weapons in the Army's Office of Research and Development, appointed vice president, planning and development, by Breeze Corporations, Inc.

Frank A. Gunther: Executive vice president and general manager of Dynamics Corporation of America's Radio Engineering Laboratories, Inc., promoted to president.

Robert L. Hirsch: Formerly manager of Aerojet-General Corp.'s Washington, D.C. office, appointed assistant to the vice president, Solid Rocket Plant.

Dr. George F. Floyd: Elected vice president, systems research for The Bissett-Berman Corp. Prior to joining the firm, he served as a senior staff member of Ramo-Wooldridge.

Burl H. Ervin: Former assistant director of applications engineering, appointed director of applications engineering for the Systems Support Dept. of Nortronics, a division of Northrop Corp.

Willard F. Bates: Named director of manufacturing for the ne Data Recorders Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

Richard Farish: Appointed manager, industrial engineering department of Perkin Electronics Corp. Was formerly in industrial engineering with Ryan Electronics, Northrop Aircraft and Douglas Aircraft.

George R. Tallent: Appointed program manager of the Motorola-Autonetics *Minuteman* Reliability Program, responsible for overall program direction and administration, including coordination of the Engineering, Production, Quality Control and Marketing Dept. Prior to joining Motorola, he was manager of Quality Control and Reliability for CBS-Electronics semiconductor operation.

Dr. Warren N. Arnquist: Missile and space research physicist, appointed assistant to the director of advanced research for the Douglas Aircraft Co. Was formerly assistant director of engineering research with the Systems Development Corp.

Eugene A. Jackson: Joins Astrosystems, Inc., as chief scientist for advanced research. He was formerly associated with Barnes Engineering Co., where he developed the electro-optical equipment used in *Tiros II*.

J. L. Clark: Appointed manager of the Ballistic Missile Early Warning System program at the Systems Engineering and Management Operation of Sylvania Electric Products, Inc.

Dr. Kenneth Mortenson: Former research physicist with the General Electric Co.'s Research Laboratory, joins Microwave Associates, Inc., to head a research group working on active solid-state microwave devices.

Dr. Gaelen L. Felt: Joins Germeshausen & Grier, Inc., as manager of the firm's Las Vegas operations. Was formerly associated with Space Technology Laboratories as staff physicist in the Vehicle Department Laboratory concerned with the application of nuclear rocket engines for missiles and space vehicles.

C. Henry Still: Named director of information services for The Martin Co.'s Baltimore division, succeeding **Fred E. Hamlin,** advanced to the newly-created post of corporate director of communications operations.

Dr. L. Edward Godycki: Former associate chemist with I.B.M. Research Laboratories, joins Electro-Optical Systems, Inc., as a senior research physicat in the company's Solid State Division.

Small Arc-Plasma Spray Gun

A KW arc-plasma hand spray gun less than 2 in. long and 1.5 in. in diameter is available from the Plasmadyne Corp.

The plasma tool weighs less than 1 lb. and makes possible the spraying of materials onto surfaces previously deemed inaccessible due to the size of the plasma gun. The gun attains an operating efficiency greater than 60%. This represents the conversion of electrical energy to heat.

The spray gun can be used with standard Plasmadyne consoles and carries a 200 hour electrode life guarantee when used with argon. Other Plasmadyne arc-plasma spray guns are manufactured in 40 and 60 KW power levels.

Circle No. 225 on Subscriber Service Card.

Modified Polybutadiene

A modified polybutadiene polymer with a unique combination of properties is available from B. F. Goodrich Chemical Co. Called Hycar 1000X145, the polymer has excellent abrasion resistance and will not become brittle even at temperatures as low as –85°F. It also has moderate resistance to the effects of fuels, solvents and chemicals.

The polymer's excellent electrical properties and ozone resistance make it an ideal material for use in the electrical wire and cable field. The use of Hycar 1000X145 in wire and cable applications could eliminate the need for different materials for use in the primary insulation and the protective sheath.

Circle No. 226 on Subscriber Service Card.

Flash Power Course

American Speedlight Corp. has available stock equipment to power electronic flash tubes. Ascorlight electronic flash equipment ranges from 0.6 duration in microseconds up to 500 million peak beam candle power. This eliminates the need for organizations investing costly man hours in designing and constructing this type of energy discharge equipment. And even if custom equipment is required, Ascor's use of standard components keeps cost down.

Circle No. 227 on Subscriber Service Card.

Traveling Wave Tube

A low-noise traveling-wave tube for use in the 7-to-11 kmc frequency range has been developed by General Electric Company for input service in radar receivers.

The metal-ceramic tube, designated Z-3103, has a noise figure less than 10 db, minimum gain of 25 db, and power output of 5 milliwatts across the entire band. It has been tested successfully to withstand shock at 50 g's and vibration at 5 g's.

Circle No. 228 on Subscriber Service Card.

Spat Transistors

Philco Corp. is marketing Silicon Precision Alloy Transistor (SPAT) produced by a unique strip alloy technique, making possible unprecedented product uniformity.

SPAT transistors feature high beta, very low saturation voltage, and high emitter base diode voltage ratings.

Circle No. 229 on Subscriber Service Card.

Quick-Connect Coupling

Jack & Heintz, Inc. is producing new design for no-air inclusion type quick-connect couplings.

Tradenamed TRIGGER LOCK and coded Series 17, these couplings form a complimentary line to the Series 10 and 11 Roto Lock couplings.

TRIGGER LOCK is aimed specifically at those applications calling for minimum leakage on disconnect, and minimum entrapment of air or other foreign matter on connect. The coupling brings improved space, weight and performance advantages to the user including: smaller size, lighter weight, faster, automatic "push pull" action for coupling and uncoupling, higher reliability over a broader temperature range, lower pressure drops and longer service life.

Circle No. 230 on Subscriber Service Card.

Load Cell Calibrator

A Load Cell Calibration System for missiles is available from Gilmore Industries, Inc. The Model 256 is a highly accurate instrument for calibrating load cell transducers. The system calibrates from 5,000 lbs. to 1,000,000 lbs. within 0.05% of reading by using three overlapping sets of Gilmore M-170 Force Calibrators. The press is hydraulically operated and arranged to handle tension and compression loads, with a stroke opening from 0 to 96 in. By a unique method of utilizing the 110,000 lbs. of dead weight at N.B.S., this system is a one-step transfer to a secondary standard.

Circle No. 231 on Subscriber Service Card.

Adjustable Micro Switch

Adjustable differential travel is a feature of a basic switch (10BS210), available from the Micro Switch division of Minneapolis-Honeywell.

A knurled wheel on top of the switch permits differential travel adjustment from 0.0025 to 0.007 inch. Changing the differential travel changes the contact break distance, the pretravel distance and the operating and differential forces. The operating force varies from 12 to 32 ounces and the differential force from 2 to 15 ounces. The release force, however, remains at 10 ounces, regardless of the differential setting.

Circle No. 232 on Subscriber Service Card.

High Accuracy Resolvers

Kearfott Division General Precision, Inc. has introduced the Z5153-004, Z5163-001, and Z5193-001 Size 28 high accuracy resolvers whose maximum error from electrical zero does

not exceed 20 seconds. In addition to the accuracy inherent in these components, they have the advantage of high versatility, since the same basic design permits their function as four-wire control transmitters, control differential transmitters, and control transformers. In a typical data transmission system, a string of three such components is coupled together to perform a desired function, with a total system error that is less than 35 seconds.

Circle No. 233 on Subscriber Service Card.

Micro Micrometer

A tiny micrometer that measures width dimensions is available from Navan Products, Inc.

The model permits direct measurements of internal groove and land widths in bores as small as a 0.25 in. diameter. The instrument can be used to check workpieces without the necessity of removing them from the machine.

Direct-measuring internal-width micrometers replace as many as six different conventional measuring devices formerly required to set up and check under-cut machining operations.

Circle No. 234 on Subscriber Service Card.

Computer Delay Lines

IMC Magnetics Corp., Gray & Kuhn Division, is marketing modular type electromagnetic delay lines which by means of their internal construction may be gauged for printed circuit board applications.

Specified as Series DL-251, these units are constructed on non-nutrient, flame retarding, plastic materials. Impedances range from approximately 300 to 600 ohms with delay times of .1 to .8 microseconds available. Dimensionally the units are .625 in. wide and run from 2 to 4 in. in length.

Circle No. 235 on Subscriber Service Card.

Operational Amplifier

George A. Philbrick Researches, Inc. has available an all-solid state Differential Operational Amplifier, Model P2. Containing neither tubes nor mechanical choppers, it is a true dc differential amplifier whose input is entirely "floating" and yet has a long term drift stability in the sub-millivolt region. Its typical input current is well under a tenth of a millimicroampere, thus making possible its use in long time-constant integrating circuits using small polystyrene capacitors ($R = 10M$, $C = 0.1$ uf for a 1 second integrator), or its use in electrometer type amplifier circuits.

Circle No. 236 on Subscriber Service Card.

Mylar Miniature Capacitor

Efcon, Inc. is marketing series of Mylar Miniature Capacitors, Types MH, MC, and MW.

These Efcon Mylar Miniatures operate in a temperature range of from –60°C to 125°C and tolerances of 125°C. Tolerances of ±20%, ±10%, ±5%, ±1% are available from standard production. Voltages range from 100 to 600 volts.

Two types, MH and MHH, are hermetically sealed in metal cases with glass-to-metal end seals. Type MC is a cardboard tubular, and Type MW is enclosed in Mylar tape with epoxy resin and seals.

Circle No. 237 on Subscriber Service Card.

Molten Metal Valves

A bellows-actuated poppet valve capable of functioning in systems handling molten lead, molten sodium or molten sodium alloys at temperatures up to 500°C has been developed by Hydrodyne Corp. for applications in chemical metallurgical, nuclear, and missile fields.

Featuring finely machined bellows and heliarc welded construction of Inconel-X, the valve can operate over a range of –430°F to +1500°F at up to 450 psi. The pressure rating in other models extends to 10,000 psi.

Circle No. 238 on Subscriber Service Card.

Automatic Analyzer

Associated Research, Inc. has available a high voltage automatic circuit and cable analyzer. The Model 8524 Analyzer embodies facilities for completely automatic continuity, insulation resistance and dielectric strength test-

ing of cables with up to one hundred and twenty conductors.

This analyzer will even completely check itself and indicate any point of malfunction. Pressing a single button causes the instrument to initiate an automatic program, testing every light, timer, meter, relay and circuit in the complete assembly.

Circle No. 239 on Subscriber Service Card.

Automatic Sweep Drive

A sweep drive which automatically sweeps oscillators and other tunable devices through their frequency ranges is now available from Hewlett-Packard Co. Model AC-97C has two sweep speeds and a neutral. The fast sweep covers the frequency spectrum rapidly while the slow sweep gives a high resolution plot. Sweeps can be reversed automatically when limits are reached,

thereby providing a continuous sweep for oscilloscope presentations, or, for convenience in X-Y recordings, the sweep can be stopped automatically when the limit is reached.

Circle No. 240 on Subscriber Service Card.

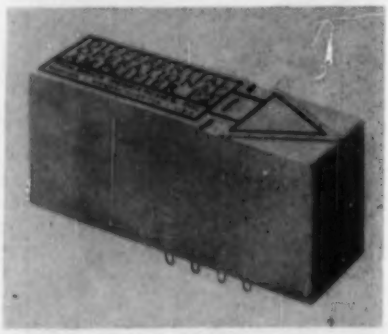
Servo Accelerometer

A variable range servo accelerometer is available from Palomar Scientific Corp. Model PAV-1S features a closed loop servo design for exceptional accuracy and stability and high sensitivity with threshold resolution of better than 1 part in 100,000. The accelerometer permits on-site selection of full scale range by means of a readily accessible adjustment. Any desired full scale range may be selected without changing output impedance or full scale output voltage.

Circle No. 241 on Subscriber Service Card.

Operational Amplifier

An operational amplifier is available from Donner Scientific Co. The solid state amplifier, Model 3801, uses silicon transistors throughout to provide both



the high gain, wide bandwidth path and the chopper stabilization path. In standard form, the Model 3801 will operate over a temperature range from 0°C to 55°C in a relative humidity of 95%. It will withstand shock of 30 G and meet all specifications to an altitude of 50,000 feet.

Circle No. 242 on Subscriber Service Card.

new literature

BALL BEARINGS—Cleaning and relubricating equipment for ball and roller bearings is the subject of a brochure published by Bearing Inspection, Inc. The described equipment will handle bearings ranging in size from ¼ in. to 14 in. OD, and it will clean most bearings with the shields in place.

Circle No. 200 on Subscriber Service Card.

D-C POWER—Bulletin GEA-6690A, listing the features, operation and applications for custom-built D-C power supplies for computers, aircraft, missiles, military and special applications is available from General Electric Co. Publication included photographs, load current graphs, and a comparison table of relative characteristics of different types of power supplies and power supply systems.

Circle No. 201 on Subscriber Service Card.

DIGITAL VOLTMETERS—A Pocket Guide to the Proper Selection of Digital Measuring Instruments, from Non-Linear Systems, Inc. The guide answers such questions as: What are the practical applications of digital measuring instruments? and How important is servicing in selecting a digital voltmeter?

Circle No. 202 on Subscriber Service Card.

GOLD ALLOY PREFORMS—Technical Bulletin Z-108 describing gold alloy preforms for use in semiconductor processing is available from Accurate Specialties Co., Inc. Bulletin Z-108 offers semiconductor engineers information on the use of gold alloy preforms for two applications—as a joining material to produce an ohmic junction, and when doped with N or P type elements, as an alloy junction material.

Circle No. 203 on Subscriber Service Card.

VARIABLE PHASE STANDARD—A brochure published by Gertsch Products, Inc. describes a variable phase standard which permits phase between 2 self-generated voltages to be shifted to any desired angle with an accuracy of ±.05° or better. A front panel switch allows operation at any of three fixed frequencies within the range of 150 to 3000 cps. Included are technical specifications, a detailed circuitry description, and a simplified block diagram.

Circle No. 204 on Subscriber Service Card.

PLASMA SPECTROGRAPH—A Plasma Research Spectograph for use in plasma diagnostics and high temperature gas research is described in a pamphlet available from Bair-Atomic, Inc. Featuring a 15,000 lines-per-inch 3-meter concave grating and modified Eagle mounting, the B/A instrument facilitates spectrochemical analysis of plasma and permits determinations of relative spectrum line intensities, Doppler and Stark broadening profile curves, continuum measurements and target ablation studies.

Circle No. 205 on Subscriber Service Card.

BALL VALVES—A design and product data file, containing descriptions of ball valves for handling cryogenic fluids, high-pressure gases and water, large propellant flows, hazardous chemicals and petroleum products, is available from The Vickery Co.

Circle No. 206 on Subscriber Service Card.

letters

Wilson's Is Blue

To the Editor:

The Dec. 5 M/R carried a fine article about Air Force General (Roscoe C.) Wilson. However, I noted what I believe was an error in the description of General Wilson's fourth-floor Pentagon office. The article stated "Behind Wilson stood his red and white three-star flag."

Unless General Wilson is using a 3-star flag of the U.S. Army or the U.S. Marine Corps, the flag would have white stars on an ultramarine *blue* field with gold fringe. This latter design was authorized for Air Force General Offices shortly after the Unification Act of 1947, creating a separate Department of the Air Force and the United States Air Force.

This is a minor type of error and in no way detracted from the excellence of the article, which I am quoting from heavily when instructing our Cadets here at Michigan Tech.

Robert F. Schirmer
Colonel, USAF
Professor of Air Science
Michigan College of Mining and Technology
Houghton, Mich.

You're correct.—Ed.

Shoot, You're Faded

To the Editor:

Please count me among the first to defend your right to editorialize, and mine to criticize. I bristled a little over your statement in the Jan. 2 M/R editorial that "We have had, actually, not a space program but a space wrangle." I happened to read this just after reading your fine resumé on page 29 of the same issue showing that we had 20 satellites in orbit to two for the Soviets. I bristled a little more over the comment of John Savas (Letters, M/R Jan. 9, p. 48) concerning the "militarists" in the Pentagon, the "military dictatorship," H-bombs and shelters; in fact, you name it and he knew all about it. Disraeli summed it up better than I could when he said, "This shows how much easier it is to be critical than to be correct." Then, upon turning the page, there in bold, black letters was your (editorial) "Military Dogma Fades Slowly, Too." What did the "too" mean? Does civilian dogma fade slowly; does military dogma do other things besides fade slowly; or does all dogma fade slowly? Shouldn't it? Webster says that dogma is, "That which is held as an opinion, esp., a definite tenet; also, a code of such tenets." The only synonym listed is doctrine. Do you want doctrine here today and gone tomorrow?

Where you really missed the point is in associating the "layers of indecision and inaction" in the Pentagon corridors, with the action that will take place when the President presses the "go" button. The "go" circuit does not run through the "layers of indecision and inaction" in the Pentagon corridors. You might just as well close up the Pentagon as the

Operational Commanders are on their way . . .

I'll say one thing, you show no favoritism—witness your "The rigidity of the military mind has its counterpart in the civilian . . ." It seems to me that a man of your position, prestige, influence and education should be a little more careful in the use of the English Language and a little less dogmatic in attitude.

Gregory K. Gregory, Jr.
Newport, R. I.

"Military Dogma Fades Slowly, Too" was an allusion to the familiar song, "Old Soldiers Never Die, They Just Fade (Slowly) Away" ("slowly" being our insertion); which seems clear enough. The rigid military and civilian minds referred to are, obviously, some of the minds in and out of uniform which direct our military policy; we resent (as only an editor can) being taken out of context. —Ed.

Right Stater

To the Editor:

Your attention is invited to a correction of the report of an Army contract in M/R, Jan. 16. The Hardaway, Oman, Farnsworth & Wright joint venture trading as Midland Constructors is from Columbus, *Georgia*, not Ohio as reported.

Please send me five reprints of "The Energy Level of Things" and ten reprints of the "Special Report on Titan" from your Sept. 5, 1960 issue.

This office and its staff really leave your magazine "dog eared" as it is passed around. They read everything and wish the publication were larger.

Arthur R. Simpson, Major, CE
Liaison & Briefing Officer
Army Corps of Engineers Ballistic
Missile Construction Office
Little Rock AFB, Ark.

Moon Colony Now?

To the Editor:

The article "Solar Flares Pose a Problem" (M/R, Jan. 9, 1961) underlines the importance of immediate colonization of the moon.

"Not only will the moon itself provide adequate radiation shielding, especially in the polar regions, but it is 20 times easier and cheaper to lift a given weight off the moon than off the earth. It would be almost infinitely easier to obtain the necessary shielding material from Deimos (the outer satellite of Mars) once we are there, but shielding will be needed on the way to that satellite, so we will in practice be limited to the moon for a beginning. The difficulty and expense of placing a man on the moon may be formidable, but they are nothing compared to those of sending up 5000 lbs. of shielding material for each person from the earth.

Insufficient attention has been given to the possibility of devising primitive survival techniques to enable men to live on the moon with a minimum of equipment from the earth. All the chemical elements needed to support life are present on the moon, and the more immediately needed ones can probably be extracted by the use of solar heat more easily than on earth, owing to the possibility of heating large areas by the use of large mirrors and absorbers made of extremely light metal foil. Certain polar craters probably contain adsorbed gases capable of being freed at temperatures below the boiling point.

Theodore B. Dufus
Los Angeles

Air Mailing Appreciated

To the Editor:

I was very glad about your decision to deliver MISSILES AND ROCKETS to your European subscribers by air mail. Let me say how much I appreciate this new service. I, personally, here in Munich now have M/R on hand one or two days after the magazine is dated. So I am able to get the latest information brand-new—a fact which is very important for a newspaperman 4000 miles away from the missile plants and spacecraft launching areas.

I first learned of your magazine in the spring of 1958, on a trip through the United States, and have been a subscriber ever since. Let me take the opportunity to point out how indispensable M/R has become to me.

Otto Merk
Munich, Germany

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editorial . . .

Toward the New Frontiers

PRESIDENT KENNEDY has moved swiftly in his first two weeks in office. The fact that the snow-choked capital has been more reminiscent of Siberia's New Lands than America's New Frontier has not slowed him down.

His State of the Union message held encouraging news for the missile/space industry and for the nation. *Polaris* is to be stepped up drastically. The entire missile program is to be accelerated. The role of the National Aeronautics and Space Administration was slighted somewhat in the speech, but the suggestion of international cooperation in this field indicated the President does not intend to overlook it.

The prospects therefore are bright for the missile/space industry, which already has rocketed in less than a decade to a $10-billion market. Some estimates place the military missile/space market alone at $20 billion in 1970.

For this now-mature industry, the sky is no longer the limit. In space, there is literally no limit. The stars beckon.

As the new Administration charts its course, MISSILES AND ROCKETS magazine is setting out toward a New Frontier of its own under new editorial guidance. We feel that as a member of the missile/space industry you may be interested in where your magazine is going.

MISSILES AND ROCKETS intends to fulfill its role as the magazine of the missile/space industry. In the past, our critics have charged us on occasion with being a spokesman only for the Army . . . or the Air Force . . . or the Navy. To clear up any possible misunderstandings, we state unequivocally that we will be a spokesman for the missile/space industry. In most cases, the interests of the industry and the military services or NASA are parallel. Where they differ, we stand on the side of industry.

We are concerned, for example, with an increasing tendency on the part of the Air Force to drop contractor names from press releases, referring only to an AF *Atlas* or AF *Titan*. One public relations officer even voiced distress to us that The Martin Co. had referred to its product in a press release as a Martin *Titan*.

BUT LET IT ALSO be clear that we will speak FOR the missile/space industry only when, in our considered opinion, the industry is right. When it is not, we intend to fulfill our necessary role as critic and speak TO the industry.

There are several marginal programs in the missile/space industry which should have been killed some time ago. Everyone in industry knows what they are. We will support efforts to drop these programs.

You will find in the months ahead more emphasis on the third word in our subtitle: Space. Here lies the future and we will devote increasing editorial attention to it. We believe strongly that the Air Force has a military mission to fill in space and we intend to fight for recognition of that fact.

For the first time in a quarter-century, there is no bomber procurement in the new budget. We mourn the end of an era. But we hail the New Frontier of our own industry: the missile/space industry.

William J. Coughlin

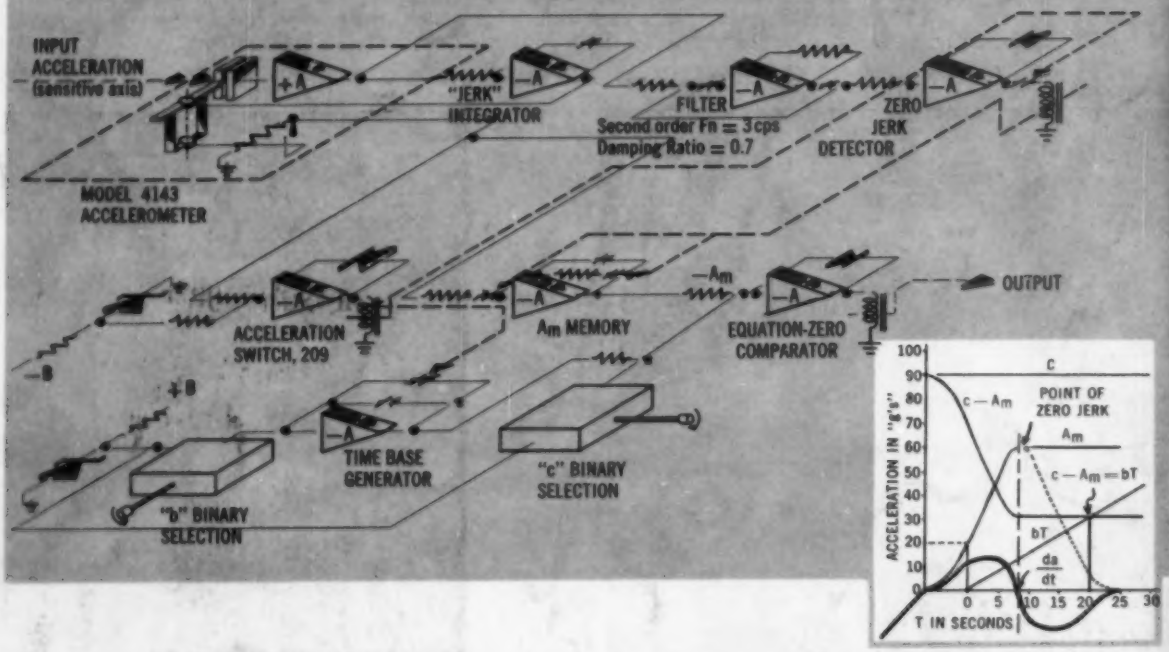
BUT, OUR PENDULUMS AREN'T SIMPLE, SIGNOR GALILEO!

Since your time, Schuler has shown that a simple pendulum can be used for navigation here on Earth if it has a period of 84.4 minutes. By your formula, Signor, the pendulum would be 3,959 miles long! We couldn't keep it simple; we had to mechanize an artificial pendulum with Schuler's long period to inertially guide the Mace missile. If you, as an engineer, would like to join us in compounding such new approaches from traditional science, and if you have a BS, MS or PhD in Physics, ME, EE, or Math, please contact Mr. E. D. Allen, Director of Scientific and Professional Employment, 7929 S. Howell, Milwaukee 1, Wisconsin.

AC SPARK PLUG ✲ THE ELECTRONICS DIVISION OF GENERAL MOTORS

1961

Functional Diagram of Donner Accelerometer Timer Switch. Basically an airborne computer designed to solve a specific equation, this Donner device consists of a force balance accelerometer, whose output feeds to a jerkmeter for determination of peak acceleration (Jerk (da/dt) is the first derivative of acceleration). From the jerkmeter the signal passes through a filter and to a zero jerk detector which closes a switch at the peak acceleration. Other units in the computer are a peak acceleration memory, a 20 g acceleration switch which starts a time base generator and prevents the zero jerk detector from operating before a correct solution is possible, "b" and "c" selection binary units allow 64 values of "b" and "c" to be selected within the operating range, and an equation zero comparator which algebraically sums the output of the maximum acceleration memory circuit, time base multiplied by "b" and "c" circuit to close the relay output when $bT = c - A_m$. The curve below illustrates the equation and the fact that peak acceleration occurs at zero jerk.



How to Solve a Flight Equation

New Donner Airborne Analog Computer solves equation $bT=c-A_m$

where b = predetermined constant, T = time in seconds,
c = predetermined constant, and A_m = peak acceleration achieved.

Causing a missile event to occur at just the right time and place in space is one of the critical problems faced by the control engineer. The programming device must be light, accurate, strong and, above all, reliable in severe environments.

When Donner engineers were confronted with this problem, they came up with a fixed purpose airborne analog computer known more specifically as an acceleration summing switch. The summing switch is a "thinking" device which responds to a particular environmental stimulus. Thinking for the vehicle, the switch measures time, multiplies it by a preset constant, equates the product to the memorized peak acceleration subtracted from a constant and when the sum reaches a predetermined value, actuates a relay. Such a point occurs during decreasing acceleration and is dependent on the magnitude of peak acceleration.

In solving this problem, Donner engineers combined their experience with computer techniques and servo force balance accelerometers. The device illustrated is all solid state.

Acceleration Summing Switch. This remarkable small computer is approximately 4" high and 2½" across. The two knobs on the top are used to set in "b" and "c" constants of the equation.

COMPLETE TECHNICAL INFORMATION AVAILABLE
If you would like more information about this interesting application of computer and transducer techniques, our Mr. Stephen P. Cuff has prepared a technical discussion which he will be happy to send along. Please write Mr. Cuff at Donner Scientific.

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